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EDUCATION AND DEVELOPMENT IN THE COLONIAL TERRITORIES

ONE reason for welcoming the annual report on the Colonial Territories* is that it places in its proper perspective the scientific work being conducted in those Territories and which is described more fully in the independent report on "Colonial Research". The present report, for 1949–50, is no exception. Indeed, the ten pages of the report dealing with research and surveys not only indicate the bearing of the work to be described more fully in a forthcoming report on economic and social development and its relation to political and constitutional developments, but also contribute to giving a clear picture of the various ramifications of international collaboration in this field. The diary of events of Colonial interest is also of service in this connexion. Indeed, the whole report is an invaluable aid to informed discussion on proposals for technical assistance to the backward areas under President Truman's 'Fourth Point', on particular projects such as the groundnuts scheme or on colonial welfare and development generally.

Compared with the previous report, the emphasis on the man-power situation is less marked. Recruitment to the British Colonial Service was at a higher level than in any pre-war year; but there is still a shortage of recruits in several branches, particularly some of those calling for professional qualifications. This shortage is attributed partly to the continuing high-level demand in Britain itself, but even more to the great expansion in the Colonies as a result of their plans for development.

This position is particularly well illustrated in regard to the developments in education during the year, and especially in higher education. The report reviews briefly those rapid developments in Colonial university education recorded in last year's report from the Inter-University Council for Higher Education in the Colonies, which formed the subject of an article by Mr. W. Adams, secretary of that Council, in a recent issue of the *Universities Quarterly*. The present report notes further that teaching in the Faculty of Arts at the University College of the West Indies and in agriculture in the Faculty of Agriculture and Veterinary Science at University College, Ibadan, will begin in October of this year. An Advisory Committee on Colonial Colleges of Arts, Science and Technology was set up by the Secretary of State at the end of 1949 and, in addition to advising on general development and the selection of staff, this Committee is responsible for recommending grants from a sum of £1,125,000 which has been made available for the three regional colleges in West Africa under the Colonial Development and Welfare Act. Principals-designate were appointed during the year for the projected college in Nigeria and for the reconstituted Fourah Bay College in Sierra Leone, and are at present determining sites and planning initial courses.

* The Colonial Territories (1949–50). (Cmd. 7958.) Pp. viii+158. (London: H.M. Stationery Office, 1950.) 4s. net.

"These colleges are expected to provide whatever courses in higher technical and commercial education are most needed. They will also undertake the training of teachers and of social welfare and community development workers, and, pending further developments in secondary education, may provide general teaching up to higher certificate standard. They are likely to become centres of adult education and of cultural and technological development generally. . . . They will also provide certain courses which at present students can follow only in the United Kingdom or elsewhere overseas."

The report adds: "Provided that the necessary staff can be found, the colleges will make an incalculable contribution to the social and economic development of the West African territories"; but the general implications are brought out better in Mr. Adams's article. Mr. Adams points out first that the development and welfare plans of the Colonies call for trained personnel in large numbers, and that in the main these specialists must come from the Colonial territories themselves. The pace of development, however, is being forced from outside, by political and constitutional as well as economic and social changes; the universities are accordingly being faced with difficult decisions in their expansion. These points are scarcely noted in the Colonial Territories report, although the political and constitutional changes are for the most part well emphasized.

The main problem is not entirely one of staff, although that factor is involved. Difficulties in recruiting staff have not, Mr. Adams holds, been as important a source of delay as was at first feared, and he comments on the encouraging response from the Dominions in recruitment. Moreover, while secondment of staff from universities in Britain has so far played a small part, secondment may become more common as the staff position eases at home and in the Dominions. The Colonial universities and colleges have also begun to make contacts at the research-student level.

The real difficulty is presented by post-secondary education. In considering whether a subject is appropriate for university teaching, a university in Britain can safely assume that provision can be made elsewhere for it. When a Colonial university, however, is asked to undertake training tasks in fields or at standards which by home conventions are not those of universities, to refuse may mean that the training is not given at all; on the other hand, to accept may invest the work with a social prestige which will impede its transfer to another type of institution later. Mr. Adams stresses the importance of diversifying the educational opportunities for the Colonial student after his secondary education in order to avoid serious repercussions on the success and speed of the development of the university institutions. Moreover, unless public opinion is convinced of the value of such experiments as the regional colleges proposed for West Africa, the colleges are scarcely likely to succeed even if the staffing problems are surmounted.

There may well be no single remedy; but the need for educational development at the primary, and especially the secondary, level is well brought out in other sections of the Colonial Territories report, and the magnitude of the consequent demand for trained man-power and the acuteness of the attendant problem of standards scarcely need to be stressed. That is apparent in the general survey which forms Part 1 of the report, in which the progress recorded in all spheres of education leads to no complacency. Among the events of the year in the educational field was the graduation of the first group of teachers from Batu Lintang, the teacher training college set up in Sarawak. Stress is also laid on the community development schemes, which differ from territory to territory but have as one recurring feature a compact team of experts working systematically in a given area, and on the striking development of the libraries of the Colonial university institutions, sometimes assisted by capital grants from Colonial Development and Welfare funds. The provision of vernacular literature is another problem, and the East Africa Literature Bureau and the Joint Publications Bureau of Northern Rhodesia and Nyasaland set up in 1948 are abundantly justifying their establishment. The Mass Education Clearing House set up in the University of London Institute of Education is also playing a valuable part.

Reviewing the health services, the report emphasizes that all available statistics point to striking improvements in health in the British Colonial Empire during the past decade, and the improvement is attributed largely to effective control of malaria, until recently the chief killing-disease in the world. Here the contribution of science is unmistakable. The complete eradication of the malaria-carrying mosquito from Cyprus announced in January 1950 was made possible mainly by repeated DDT spraying of every possible mosquito-breeding place over a period of three years. By similar methods, some ninety-five per cent of the people of British Guiana are now enjoying protection from malaria; and in Mauritius, too, the full-scale programme of mosquito eradication now in progress should at least greatly diminish the disease.

It is possible that DDT may prove to be almost equally effective in combating the tsetse fly, the carrier of sleeping sickness in Africa. Experiments in Tanganyika with insecticide smoke from aircraft have already demonstrated that, under certain conditions, all the flies can be killed in blocks of infested bush some five to six square miles in extent, while the survey also refers to investigations in East and West Africa into problems of tsetse-borne diseases in cattle. Other new drugs offer hope that diseases prevalent in the tropics will be brought under control far more rapidly than could have been foreseen a few years ago: for example, hope is offered for lepers by the development of certain drugs, and a wide application of B.C.G. vaccine in the treatment of tuberculosis is contemplated.

The importance of the scientific contribution was also well brought out in a paper which Sir Harold Tempany read before the Society of Chemical Industry last January. Dealing with the agricultural problems of the Colonial dependencies, Sir Harold touched on

many problems affecting economic development which are mentioned in this report and indicated some of the deficiencies in our existing knowledge of such matters as tropical soils, climatic conditions, the fertilizer requirements of tropical crops and other factors which affect both plantation and peasant agriculture alike. These gaps, like the surveys, which both Sir Harold and the Colonial report urge, depend on scientific study and research just as much as the new measures for the control of animal diseases or the control of pests and diseases of plant crops, whether by breeding immune or resistant strains or varieties, or by biological or chemical methods.

Here and elsewhere, as in his reference to the high importance of the co-ordination of research and development in British territories with those in adjoining countries, especially in such matters as the conservation of soil or control of disease, Sir Harold's views run parallel with many passages in the present survey of the Colonial Territories. The shortage of senior technical staff which continues to be a limiting factor is being alleviated by provision, under the Economic Co-operation Agreement between Britain and the United States, of the services of American technicians and scientific workers for various projects and investigations in Africa and the West Indies, such as the pilot survey for a link between the railway systems in East Africa and the Rhodesias. Further American aid is being given to expedite and increase the production of such 'deficiency materials' as kyanite, cobalt and bauxite, and assistance has been formally sought for twenty-nine projects involving a total expenditure of 7·6 million dollars. A leading American ecologist has arrived in the United Kingdom to work upon locust-control problems, and the temporary engagement of American workers to strengthen existing research organisations in several Colonies is foreshadowed.

The survey also gives a concise picture of the international collaboration proceeding in technical and other matters not only under the auspices of the United Nations but also directly between the Colonial Powers; the establishment by the Governments of Belgium, France, Portugal, Southern Rhodesia, the Union of South Africa and the United Kingdom of a Commission for Technical Co-operation in Africa south of the Sahara and co-operation in locust control are specially mentioned. Regional co-operation also continued satisfactorily, taking the form in Africa of discussions on technical matters and of the exchange of visits and information. The Caribbean Commission met twice during the year, and the participating governments re-affirmed their support of the Commission as an advisory body on regional, social and economic problems. The South Pacific Commission has established its permanent headquarters in Noumea, New Caledonia, and its programme of research provides for twenty-eight projects. In the same connexion, it may be noted that the Colonial Office, which on April 1, 1949, took over responsibility for the scientific sections of the Imperial Institute doing work in the Colonial sphere, continued to be engaged on the affairs of the West African Cacao Research Institute and the West African Institute for Trypanosomiasis Research. Legislation is at an advanced state to allow the establishment of the latter as a corporate body, and with the appointment of a new director of fisheries the development of the West African Fisheries Research Institute will be started again. A five-year programme of research and development, costing three million pounds, has been agreed for the Rubber Research Institute of Malaya, the British Rubber Producers' Research Association and the British Rubber Development Board.

Generally, it may be said that, although the constitutional developments recorded in the Survey, such as the proposals for a British Caribbean Federation, for a new constitution in the Gold Coast, with an Executive Council including eight African Ministers appointed from the legislature, and for a new Nigerian constitution are the most spectacular developments recorded in the survey, the impression is left that the pace of economic and social development is now reaching the limit when it will be determined by financial and social considerations and not as hitherto by the availability of materials or man-power. Equally it is clear that political factors are tending to set a pace incompatible with the provision of a firm social, economic or scientific basis for real advance.

This is well illustrated by two matters referred to in the review of economic development. An important experiment is being conducted in Nigeria to demonstrate that the use of artificial fertilizers is within the reach of the African peasant. In the first instance, a special staff will supply groundnut growers with fertilizers free of cost in a form which makes it simple for the peasant to apply a suitable dose as he sows the seed. The special staff will demonstrate a technique which should enable farmers to obtain good increases in yield by applying a fraction of the quantity of fertilizer required when it is applied by the traditional broadcast method. If successful, the technique will be extended to other crops. In the meantime, it is of special interest in view of the further light thrown on the failure of the East African groundnut scheme by the recent report from the Committee of Public Accounts, as well as by Mr. Alan Wood's book, "The Groundnut Affair". The experiments will doubtless be watched with interest by the Working Party appointed by the Overseas Food Corporation.

The second point is in regard to the virus diseases of cocoa known as swollen shoot. It is clear, according to this report, that remedial measures are not keeping pace with the spread of the disease in the Gold Coast, and the new Governor decided to ask the legislature for the re-imposition of compulsory powers in areas where the majority of the farmers are in favour of cutting out. Besides this, however, an agreement has been concluded with Pest Control, Ltd., whereby a team of three scientific workers provided by the Company are to be attached to the West African Cacao Research Institute to carry out a programme of research into the possible use of systemic insecticides in controlling the spread of swollen shoot disease.

At least three years must elapse before there can be any question of applying such control methods on a field scale, and accordingly, like the Nigerian experiment, this development emphasizes the difficulties that arise when political or economic factors are urging a pace of development quite incompatible with the scientific survey and examination which provide the firm basis for real advance. Even if the Survey suggests that the difficulties with regard to scientific and technical man-power are no longer quite so acute, no scientific man or professional man who reads this Survey can remain in any doubt as to the extent of the demand which the Colonial Territories must make for years to come on the universities and the professional associations of the country and on the Colonial Service for trained men and women, if only in training their own peoples and building up professional ideals and traditions in those territories. Nor can that be done without simultaneously a great expansion in secondary education in the Colonial territories to provide the technicians and teachers, and above all the educated middle class outside the Government service upon which the application of the new techniques and the stability of political and social life will largely depend. "The Colonial Territories, 1949–50" possibly underrates the gravity of certain political factors, notably the seriousness of the situation in Malaya and the deterioration of racial relations in Africa; but it sets most admirably in a larger context the work of the man of science described more fully in the reports on "Colonial Research". It should be read and pondered by all concerned with such work, and by those who reflect on the larger issues involved in the relations of Great Britain with its Colonial territories, our interdependence, political as well as economic, and our ability to inspire the young leaders which the Colonial universities will increasingly provide for their communities with a vision and faith equal to the demands of the modern world.

PRODUCTION OF ANTIBODIES

The Production of Antibodies

By Dr. F. M. Burnet and Dr. Frank Fenner. (Monograph of the Walter and Eliza Hall Institute, Melbourne.) Second edition. Pp. viii+142. (Melbourne and London: Macmillan and Co., Ltd., 1949.) 12*s.* 6*d.* net.

THE first edition of this essay, published in 1941, has long been rather hard to come by, and the appearance of a second is therefore proportionately more welcome. Since the publication of the first edition, and to a large extent because of it, antibodies have been interesting biologists more and more, in spite of the inroads of antibiotics into their therapeutic uses.

Dr. F. M. Burnet has not changed his ground. Antibody formation is thought to be the consequence of an *inherited* change in the pattern of synthesis of serum globulin in mesenchymal cells; that is, a change which endures through repeated fissions long after the physical disappearance of the agent which in the first place brought it about. (It makes no important difference to the theory what sort of cell actually makes antibodies, and the authors now give due weight to recent evidence incriminating the plasma cell and the lymphocyte, or its precursor.) According to Burnet's theory, therefore, antibody-formation is the outcome of an inherited cellular transformation. The 'chemical' theory, which in one form or another the authors couple with the names of Mudd, Haurowitz and Pauling, requires the continued presence of antigen during the entire term of antibody formation, the antigen being (crudely) a mould or template for distorting normal into antibody globulin. It is clearly a matter of the utmost technical difficulty to decide whether antibody formation outlives its stimulus or not, and the evidence one way or the other is at present quite inconclusive.

The incompatibility between the chemical and 'biological' theories turns solely on the question of whether or not a cellular transformation is entailed. As the authors point out, the mechanism envisaged by the chemical theory may well prove to be correct in principle, though it may not take place at such a late stage in the assembly line of globulin synthesis as is commonly thought. It is essential for Burnet's theory that the formation of antibodies is subsidized by a cytoplasmic self-reproducing system. Extracellular proteins like serum globulins are the reproductively inert by-products of the synthetic activity of an enzyme system which is undergoing continual replication in the cytoplasm. Antibody is serum globulin formed as the by-product of an enzyme system which, under the impress of antigen, has submitted to a slight inherited change that is in some important ways analogous to that responsible for the formation of adaptive enzymes in bacteria—an analogy supported since the publication of the first edition by Hinshelwood's interpretation of the adaptive process. The sort of molecular distortion envisaged by the chemical theory might be supposed to occur in the Burnet enzyme system itself rather than in the texture of its finished product—an idea which fits easily into the pattern of modern speculation about the nature of self-reproducing systems.

However, the authors would be the first to admit that much of the evidence they bring forward in support of their views is no more than suggestive. The existence of a short phase of exponential expansion of circulating antibody is poor evidence for the existence of a multiplicative antibody-forming system, though it is certainly consistent with such a possibility; and as evidence that antibody formation outlives its antigenic stimulus, the very long-drawn-out immunity that follows infection by some viruses is admittedly clouded by the possibility that a trace infection by virus does indeed persist. But to say this is to say the worst: this is a book which will stimulate or goad every immunologist into thinking afresh about old problems and coming to terms with new ones. Among the matter new to this edition is an ingenious and most stimulating commentary on the important and disturbing fact that embryos do not form antibodies, worked in with a theory of how antibody-forming cells come to distinguish native from foreign organic molecules. Another is the chapter on transplantation immunity, containing the suggestion that the response to the grafting of foreign homologous cells has something in common with the type of sensitivity provoked by tuberculin.

In summary, the immunologist needs no special inducement to read this essay, for he will do so anyway; but it is important that every biologist interested in the problems of cellular heredity and transformation should be aware of the rather direct bearing of antibody formation upon them.

A LIFETIME'S WORK ON TROPICAL MEDICINE

Happy Toil

Fifty-five Years of Tropical Medicine. By Major-General Sir Leonard Rogers. Pp. xvi+271+8 plates. (London: Frederick Muller, Ltd., 1950.) 18*s*. net.

A BOOK such as "Happy Toil" could only have been written by a Happy Warrior, and that in the person of Sir Leonard Rogers. It therefore follows that it supplies a record, breathing of that zest and burning enthusiasm which have emanated from his person throughout his long life. Sir Leonard's personality is engraven on every word, whether we pursue him on his bicycle scudding up and down impossible mountains or dodging elephants and leopards in his path. It is the same indomitable spirit which enabled him to flout conventions, to beard authority in its den, to discard his uniform whenever possible, and to refuse to budge one iota from his principles in order to placate his fellow men, but which finally enabled him to triumph over every conceivable obstacle.

This book has the spirit which led to discoveries of the first order, and in this category must be placed his researches on amœbiasis and that extraordinary reasoning which enabled him to place emetine treatment on a scientific basis. Next in order of importance must come his clarification of the life-history of Leishmania and the application of antimony therapy to the treatment of kala-azar. Although we may not all agree with his physiological tenets, nevertheless he introduced a new principle in the treatment of cholera. All the world knows of his struggles in the treatment of that hideous mutilating disease—leprosy. Throughout it all, Sir Leonard's super-optimism has carried him through, so that no one can deny that, as the result of his foundation of the British Empire Leprosy Relief Association, the lot of the leper has been revolutionized and the standard of treatment much improved.

Some, indeed, may cavil at the sweeping conclusions he has deduced from most intense, detailed and laborious studies in official blue books. In these he juggles with columns of figures on the incidence of cholera, pneumonia and smallpox in India. It might be suggested that sometimes the figures and methods of their assessment are not always reliable; but this has not deterred him from arriving at definite conclusions regarding the forecasting of epidemics.

There is no one who has possessed the drive, energy, enthusiasm and business capacity of Sir Leonard—or indeed one who could have extracted such large sums from the official and business circles of Calcutta. The School of Tropical Medicine there, together with the Carmichael Hospital for Tropical Diseases, will for ever stand as memorials to the memory of this great Englishman. That he is brave and determined has been shown on many occasions, in his handling of poisonous snakes, as well as in his successful battles against the anti-vivisectionists which graced the close of his career. There is a grand vein of optimism running through this book; but it could not be otherwise.

Sir Leonard would have you know that he has a profound divine faith and a deep belief in himself, his ancestry and his upbringing; he is also deeply conscious of his debt to science which he has repaid in generous gifts and in the value of the scientific work which he has so happily accomplished. He has penned a fine tribute to his wife, as is just, and his account of their courtship forms one of the most delightful interludes of his book. "No; she had not got cholera, but she had definitely got him."

PHILIP MANSON-BAHR

HEAT FOR DEGREE STUDENTS

A Textbook on Heat

By J. H. Awbery. Pp. x+302. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1949.) 15*s*. net.

MOST teachers of physics are aware of the importance of a sound knowledge of what is usually called classical physics. Classical physics, however, consists of the less spectacular and older branches, of which heat is one, and, in competition with the more attractive and rapidly advancing modern branches such as atomic physics or electronics, it nowadays receives inadequate treatment. This is due in no small part to the lack of suitable up-to-date text-books. However admirable Preston's "Heat" may be, it nevertheless does not attract the present-day undergraduate. The volume under review is a contribution in the right direction. It is written by a recognized authority on heat and an experienced research worker, and the original and stimulating manner in which the material is presented should prove acceptable to most readers. In place of the traditional detailed treatment of the thermal behaviour of substances and somewhat elaborate descriptions of experimental arrangements, the author has concentrated on fundamental principles and has tried to state clearly and precisely what are the essential features of particular investigations.

From a discussion of temperature and its measurement, the volume proceeds to the point where heat is found to be measurable, and from there to the relation between heat and energy. The first and second laws of thermodynamics, the properties of gases, the phase rule, the properties of solids, thermal expansion, and the properties of liquids with change of phase are then dealt with in that order. Three chapters on heat transfer follow, and after a chapter on statistical mechanics the book concludes with a discussion of the applications of thermodynamics to heat engines and to chemistry.

The standard is stated to be that of the ordinary degree; but it varies greatly from chapter to chapter. For example, the chapter on thermal expansion is most elementary, but those on statistical mechanics, conduction and convection, in particular, are more suitable for an advanced honours course. In some places there are unnecessarily long and involved mathematical discussions as though the reader is expected to have only limited mathematical ability; yet in other places second-order partial differential equations, Fourier series and the complex variable are introduced without much comment.

In the preface the author regrets that he has no teaching experience, and that because of this the book contains no examples. But this is by no means the only disappointing feature. All the illustrations are line diagrams, and several of them lack detail or are incomplete. Although the author stresses the importance of correct correlation of units, he fails in many places to follow his own advice. On some occasions the author's expressions are not well chosen. In its present form the work should be used for reference and with some caution, but after careful revision it should become a standard text-book for undergraduate use.

S. WEINTROUB

JUVENILE CRIME AND ITS CAUSES

Delinquency and Human Nature

By D. H. Stott. Pp. viii+460. (Dunfermline: Carnegie United Kingdom Trust, 1950.)

DURING the Second World War it was predicted by several psychologists that its termination would be followed, not by a diminution in the figures for juvenile delinquency, but by a further increase. Accordingly, in 1945 it was suggested to the Carnegie United Kingdom Trust that an intensive study of a group of adolescent offenders should be undertaken by an investigator who might be allowed to reside at an approved school as though he were an ordinary member of the staff. Mr. D. H. Stott has spent four years studying delinquents in this way; and the Trust has now published a full report of his observations and conclusions.

From a scientific point of view, one of the most interesting sections of Mr. Stott's report is his critical examination of the procedures that could be followed in researches of this type. He makes out a convincing case for using "a standard technique of investigation". In drawing up his own scheme he owes much, he says, to the advice of Prof. C. A. Mace on the logical nature of the issues involved and to Sir Cyril Burt for "schooling in method". Burt's method consisted in the combination of a case-study procedure, to elucidate causation, with a statistical procedure, to verify causal hypotheses. Mr. Stott, however, considers that the two modes of attack should be separated. He deplores the "insightless use of statistics" by recent psychiatric writers and urges that a systematic and intensive investigation of apparent causes should precede any attempt to collect numerical data on a wider scale. His present inquiry has therefore been limited to a detailed study of a hundred residents in a single approved school. This, however, he hopes will be supplemented later on by a more extensive survey to secure what he calls "statistical verification of sectional hypotheses".

A special merit of Mr. Stott's approach is that he treats crime as essentially a social and psychological problem, not as a psychiatric problem. Recent attempts to interpret delinquent behaviour in quasi-medical terms are, he maintains, largely due to the fact that the psychiatrists dealing with such cases generally have no basic knowledge of normal psychology, and consequently tend to envisage the problems that they encounter in terms of the pathological processes with which they are more familiar. "They cling to the ingenuous assumption, borrowed from their training in medicine, that what they regard as psychopathic states are due to some disease." He himself looks upon delinquency, not as a form of mental illness to be studied by the medical psychologist, but rather as an intelligible mode of reaction to an intolerable situation.

Nevertheless, he, too, seems more familiar with psychoanalytic studies of the abnormal than with the psychology of normal human nature. As a rule, he sets down his observations and his conclusions in the improvised and figurative phraseology of the psychiatrist rather than in the more rigorously defined terminology of the psychologist; and his conclusions about the causation of delinquency are admittedly based on analogies drawn from theories about neurotic disorder. Delinquent breakdown, he considers, is similar to nervous breakdown—to shell-shock, for example. There is first a rising tension set up by some long-standing situation which becomes at last almost unbearable. With his own cases this situation usually arose out of the unhappy emotional relations between the child and his parents, so that "the problem of delinquency is in great measure the problem of the unsatisfactory family". Then, when the child's nervous exhaustion has almost reached its tolerance-limit, a crisis factor—some spectacular event, such as a parental quarrel, a war-time shock or a narrow escape from a physical accident that leaves behind a chronic fear—seems to precipitate the actual lapse, which usually takes the form of a blind plunge into some wild or daring adventure. After all, therefore, so Mr. Stott goes on to suggest, a plausible case may be made out for treating the habitual offender "as a sick person".

However, the whole theory admittedly rests on what he terms his "very tentative hypothesis of nervous resources", supplemented by the psychoanalytic notion of avoidance-reactions. There can be little doubt that some delinquent careers start in this way: Mr. Stott's own examples, as well as the work of earlier investigators, provide convincing evidence to this effect. But what is far more questionable is his attempt to generalize this explanation in a manner which tacitly assumes that delinquency is a single specific condition due always to one and the same type of cause. The vast majority of the cases studied by Mr. Stott had been removed to an approved school just because their home situation was so unsatisfactory. How often would the same factors be found among delinquents who had not been removed on this account?

If we view the problem from the point of view of the biologist rather than from that of the pathologist, is it not possible, without invoking any new hypothesis about "nervous resources", to explain most of the early delinquencies of the young as the result of perfectly normal impulses? When a kitten steals meat from the larder, fights the cat next door or runs away and gets lost, we do not postulate a prolonged intolerable strain at home, with a crisis-factor to account for the final breakdown. The natural impulses of young children are of much the same general type; and, if uncorrected, may easily get fixed as habits. The problem rather is: What methods of moral training can be successfully adopted to forestall this uncivilized behaviour, and why do existing methods so often fail? If we may judge by published statistics, the after-histories of child guidance cases seem to show that, although a few delinquents of psychoneurotic type undoubtedly benefit by medical treatment, the majority respond far better to some form of moral re-education than to 'therapeutic treatment' in the psychiatric sense.

NEW PHOTOSENSITIVE PIGMENTS FROM THE TENCH RETINA

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THE wave-length of maximum light absorption for visual violet, the scotopic pigment possessed by fresh-water fishes, is given as 535–540 mμ by Kottgen and Abelsdorff[1]. This figure has been criticized by Wald[2] because it was obtained by subtracting the absorption spectrum of the bleached solution from that of the original solution. While agreeing with Kottgen and Abelsdorff's result for the 'difference' spectrum, Wald states that the true position of maximum absorption by visual violet is 522 ± 2 mμ.

These two figures are surprisingly far apart. In the case of visual purple the maximum of the difference spectrum is not perceptibly different from that of the unbleached solution, provided conditions are alkaline. Even in an acid solution, when the absorption of the bleached products advances well into the visible spectrum, the effect is quite small. It was accordingly thought that Wald's estimate had been 'pulled' too far into the blue by reason of the presence of yellow impurities and that the difference spectrum gave a closer approximation to the true figure. This view received apparent confirmation when an extract of roach (*Rutilus rutilus*) retinæ yielded a broad maximum at 522 mμ, and an extract of bleak (*Alburnus lucidus*) a well-defined maximum at 530 mμ, the maxima of the difference spectra being at 540 mμ and 533 mμ, respectively.

Recent experiments with the tench (*Tinca tinca*) have thrown an entirely new light on the problem, however.

The retinæ from five dark-adapted tench (5¾–6½ in.) were carefully removed and washed first in 0·6 per cent sodium chloride and then in McIlvaine's *p*H 4·6 buffer. They were then extracted three times with 1½ c.c. of aqueous 2 per cent digitonin. The extracts were bulked and made alkaline by the addition of 0·45 c.c. of *M* disodium hydrogen phosphate. The total weight of this solution (extract 1) was 4·99 gm. and its *p*H 7·7.

The absorption spectrum of extract 1 in the mid-visible range is shown in curve 1 of Fig. 1 (densities for 0·5 cm. optical path). There is a broad maximum at 470 mμ and an inflexion at about 530 mμ. On exposure to light, the solution bleached, first to orange-yellow then to lemon-yellow. The absorption of the fully bleached solution is given by curve II and the 'difference' spectrum by curve III. The 'difference' spectrum has two maxima (at 492 mμ and 512 mμ) and is totally unlike a visual violet 'difference' spectrum. If visual violet is present in this extract, then it is clear that, in addition, there must be photosensitive pigments absorbing maximally in the blue in order to account for such a difference spectrum.

As no more of this solution was available, a further extract (extract 2) was made from five dark-adapted tench (4½–5¾ in.). The previous procedures were repeated, except that the washing with *p*H 4·6 was substituted by one with *p*H 6·5 to minimize possible destruction of pigments by acid buffer, and that less digitonin was used in order to obtain a more concentrated solution. The total weight of this extract was 2·245 gm. and its *p*H 7·4.

The absorption spectrum of a portion of extract 2 was measured (curve I, Fig. 2). It was then exposed for two hours to light of wave-length 610 mμ (597–623 mμ) provided by a Hilger Barfit monochromator with 18 amp. D.C. strip filament lamp, an image of the telescope lens being formed on the front surface of the optical cell containing the solution. The absorption spectrum was then remeasured (curve II). The change in absorption (curve IV) as a result of this exposure is in good agreement with a typical 'difference' spectrum of visual violet. It should be noted, however, that the 'retinene$_2$' band, stated by Wald[2] as maximal at 405 mμ, has, in this case, two peaks, at 390 mμ and 416 mμ (indicated by the arrows in Fig. 2).

After the measurement of curve II, the solution was exposed to 'white' light from a metal filament lamp to complete the bleaching. The absorption spectrum was then measured once more (curve III, Fig. 2). The resulting further change in density is shown by curve V, which is the difference between curves II and III. Curve V has a well-defined maximum at 472 mμ and points of inflexion at 420 mμ on the blue side and at 540 mμ and 600 mμ on the red side. The inflexion at 540 mμ indicates that not all the 'visual violet' was removed by bleaching with the red light. If it is assumed that all the absorption of curve V at 620 mμ is due to the pigments responsible for curve IV, and a subtractive correction proportional to curve IV be made to curve V throughout the spectrum, curve VI is obtained. The effect of this operation is to remove largely the inflexions at 540 mμ and at 600 mμ and to accentuate the one at 420 mμ.

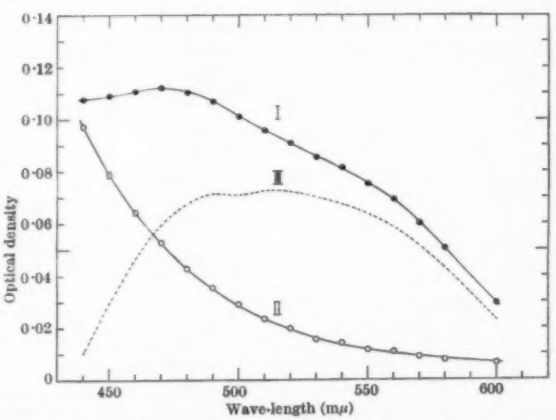

Fig. 1. First extract of tench retinæ. Curve I, the absorption spectrum of the extract. Curve II, the same after exposure to 'white' light. Curve III, the difference between curves I and II

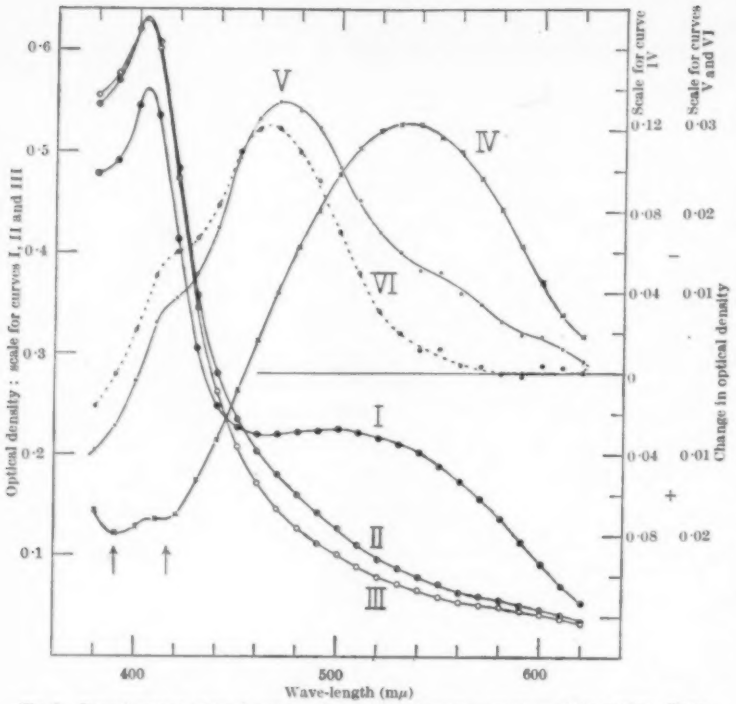

Fig. 2. Second extract of tench retinæ. Curve I, the absorption spectrum of the extract. Curve II, the same after two hours exposure to red light ($\lambda = 610$ mμ). Curve III, the same after further exposure to 'white' light. Curve IV, the difference between curves I and II, showing the difference spectrum of pigments bleached by the red light. Curve V, the difference between curves II and III, showing the difference spectrum of pigments insensitive to red light. Curve VI, see text. Note the differing scales for the density

of the two pigments. In the first place, the full-line curve is a 'difference' spectrum, and hence the short wave-length 'arms' descend too steeply because of the rising absorption of the yellow products of bleaching. Secondly, the pigments have absorption maxima fairly close together, which will result in mutual distortion. Finally, the shape of the curve from 500 mμ onwards indicates the presence of visual violet even after six hours exposure to light of wave-length 610 mμ (cf. curves V and VI, Fig. 2). An approximate correction for this last effect may be made by assuming that all the absorption at 560 mμ is due to visual violet (curve IV, Fig. 2) and applying a proportional correction throughout the spectrum. When all the readings are corrected in this manner, the broken line of Fig. 3 is obtained. This correction has little effect on the positions of the two maxima.

It is noteworthy that the apparent positions of the maxima of the two new pigments have varied but little as their relative amounts have changed with selective bleaching. For this reason, it is considered that the wave-lengths quoted, namely, 407 mμ and 475 mμ, are within ± 5 mμ of the true positions.

The inference from these experiments is that in the present retinal extracts there exist, in addition to visual violet, at least two other photosensitive pigments.

In order to obtain more accurate information regarding the positions of the absorption maxima of these pigments, the following further experiments were carried out.

Another sample of extract 2 was exposed to the monochromatic light ($\lambda = 610$ mμ) for six hours. The absorption spectrum was then measured and found to be similar to that shown in curve II, Fig. 2. The solution was then exposed to light of wave-length 530 mμ (517–543 mμ) for an hour and three-quarters. The absorption spectrum was then again measured. The *change* is shown in Fig. 3 (full line), which clearly indicates that exposure to light of wave-length 530 mμ after an initial bleach with light of wave-length 610 mμ to remove 'visual violet' results in the disappearance of two pigments having absorption maxima at 407 mμ and 475 mμ respectively. Further bleachings of the solution with light of wave-length 500 mμ and finally with 'white' light confirmed the positions of the maxima and further showed, by reason of their varying relative heights, that they were, in fact, due to two pigments and not to a single pigment.

The portions above the 'zero' line of Fig. 3 are not, of course, the true absorption curves

During the measurement of all the absorption spectra described in this communication, the temperature of the pigment solutions was maintained thermostatically at 20·0 ± 0·1° C. From two to five determinations of the optical density were made at

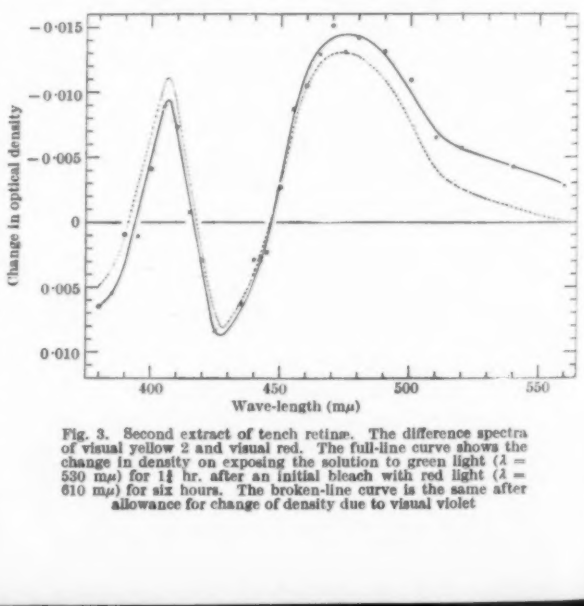

Fig. 3. Second extract of tench retinæ. The difference spectra of visual yellow 2 and visual red. The full-line curve shows the change in density on exposing the solution to green light ($\lambda = 530$ mμ) for 1½ hr. after an initial bleach with red light ($\lambda = 610$ mμ) for six hours. The broken-line curve is the same after allowance for change of density due to visual violet

each wave-length and the average taken. Under these conditions the determinations of the mean optical density could be repeated to 0·0005.

Since the measurement of an absorption spectrum may take up to an hour, check measurements of the density at selected wave-lengths were made at intervals to determine if any changes were taking place in the solutions during the measurement. Alternatively, the method of 'spanning' was used. In Fig. 3 the observations marked with a circle were taken first, from left to right, that is, from short to long wave-lengths. The observations marked with a cross were then taken from right to left. In all the absorption spectra described in this communication, no changes outside the above-mentioned experimental error occurred during measurement.

The names proposed for the two new pigments, together with their wave-lengths of maximum absorption ($\lambda_{max.}$), are :

$\lambda_{max.}$ (mμ)	Proposed name
407 ± 5	Visual yellow 2
475 ± 5	Visual red

The principle adopted in choosing these names has been that employed for visual purple and visual violet, namely, to select the colour name *complementary* to that of the wave-length of maximum absorption. It would, perhaps, have been more desirable to indicate the *visual* functions appropriate to the pigments by naming them after the colours of their wave-lengths of maximum absorption ; but the names visual purple and visual violet are too well established to warrant any change now. It is unfortunate that the term 'visual yellow' was once used for the yellow products of bleaching of visual purple ; but happily it has now fallen into disuse in this connexion, having been replaced by such terms as 'indicator yellow' and 'retinene'.

Since the true absorption spectra of none of the pigments found in the tench retina is, as yet, known with any accuracy, it is not possible at this stage to form a precise idea of their relative densities in the retina. Visual violet is, of course, present in greatest density ; but the amounts of visual yellow 2 and visual red are also considerable. Moreover, the red safe light (Ilford monochromatic filter 609 with a torch) used as a source of illumination during the extraction would cause considerable bleaching of any photosensitive pigments which may exist at the long wave-length end of the spectrum. The relatively large amounts of yellow material released into the buffer solution when washing the retinæ prior to extraction with digitonin, not to mention the large absorption in the blue in the digitonin extracts themselves (see Fig. 2), may be the bleached products of such pigments. The presence of these yellow substances may also account for the fact that the difference spectrum obtained by Bayliss, Lythgoe and Tansley[3] for the tench over their wave-length range of 480–650 mμ agrees with curve IV of Fig. 2 and not with curve III of Fig. 1. The yellow substances would act as an efficient internal filter and if, in addition, the bleaching light used were weak in the blue, it is possible that visual yellow 2 and visual red would remain largely unbleached.

In accordance with the quantum theory, it is preferable to consider the *frequency* of the light maximally absorbed by a pigment, rather than the more familiar wave-length. If this is done for the known visual pigments, it is at once apparent that the differences between the frequencies of maximum absorption ($\nu_{max.}$) for the different pigments are either equal to $0{\cdot}35 \times 10^{14}$ per second or to some simple multiple of this quantity. With this guide it is possible to draw up a table, the gaps in which probably correspond to visual pigments awaiting discovery.

Pigment	$\lambda_{max.}$ (mμ)	$\nu_{max.} \times 10^{-14}$ (per sec.)	$\Delta\nu_{max.} \times 10^{-14}$ (per sec.)
Visual yellow 2	407	7·366	
—	(427)	(7·015)	3 × 0·351
—	(450)	(6·664)	
Visual red	475	6·312	0·340
Visual purple	502	5·972	0·347
Visual violet	533	5·625	0·365
Iodopsin[4] (Visual blue)	570	5·260	
—	(609)	(4·925)	
—	(655)	(4·577)	

The table has been extended by the addition of two hypothetical pigments after visual blue (iodopsin) with maxima at 609 mμ and 655 mμ. Some evidence for the existence of the former was, in fact, obtained in the present solutions, as can be seen from Fig. 2 (curve V). Places for these additional pigments have been included in the table because Granit[5] has found maximal activity with the micro-electrode both at 610 mμ and at 640–650 mμ in the tench as well as at 530 mμ. Unfortunately, his studies with this fish in the light-adapted state were not carried below 500 mμ, so that the activity to be expected from the presence of visual yellow 2 and visual red has not been recorded. The maximum of visual yellow 2 (407 mμ) is beyond the range studied by Granit ; but activity at 475 mμ (visual red) has frequently been observed by him in other animals[6].

It is interesting to note that maximal modulator or dominator activity has been recorded by Granit at or close to all the $\lambda_{max.}$ positions shown in the table except at 407 mμ.

[1] Kottgen, E., and Abelsdorff, G., *Z. Psych. u. Physiol. Sinnesorgane*, **12**, 161 (1896).
[2] Wald, G., *Documenta Ophthalmologica*, **3**, 94 (1949).
[3] Bayliss, L. E., Lythgoe, R. J., and Tansley, K., *Proc. Roy. Soc.*, B, **120**, 95 (1936).
[4] Wald, G., *Nature*, **140**, 545 (1937). Bliss, A. F., *J. Gen. Physiol.*, **29**, 277 (1946).
[5] Granit, R., *Acta physiol. Scand.*, **2**, 334 (1941).
[6] Granit, R., "Sensory Mechanisms of the Retina" (Oxford Univ. Press, 1947).

THE ATOMIC ENERGY RESEARCH ESTABLISHMENT

TWO YEARS PROGRESS

A SECOND Press visit to the Atomic Energy Research Establishment at Harwell took place recently, when some of the progress achieved in the past two years was shown : this article is based on the information and demonstrations given on that occasion.

Since the previous visit (see *Nature*, **162**, 317 ; 1948), the greater part of the Establishment's building programme has been completed, most of the experimental facilities have been installed and are working, and the scientific and technical staff has been built up nearly to its planned level. The primary commitment of the Establishment so far has been to provide information to the atomic energy production organisa-

tion, which is responsible for the piles and chemical separation plant for plutonium production at Windscale in Cumberland. This work has occupied the major part of Harwell's effort, and particularly of the chemistry, chemical engineering and metallurgy divisions. However, some progress has been made in design studies on experimental reactors for power production, and increasing effort is now being devoted to this work. A small team has rapidly expanded the production of radioactive isotopes, and in addition to users in Great Britain more than a hundred samples per month are exported to Europe and the British Commonwealth.

The following sections give short accounts of some aspects of the work at Harwell.

Chemical Engineering

The Chemical Engineering Division is concerned with most parts of the atomic energy programme, including extraction of uranium from its ores, the technology of materials used in reactors, and development on a pilot-plant scale of chemical separation methods for plutonium and other isotopes.

Uranium is very widely distributed throughout the world—the total quantity is estimated at about the same as copper and four times as much as lead—but there are few rich deposits. It is therefore necessary to develop economic methods of extracting uranium from low-grade ores, and to select the best method for use with a specific ore. For this work the mineral-dressing laboratory has been equipped with most of the modern types of small-scale mineral-dressing equipment. The laboratory has two main functions: first, to examine the ore to determine the manner in which the uranium is distributed in it, and to determine whether differences in the physical properties of the constituents of the ore are likely to be of value in concentrating the uranium into a smaller bulk; secondly, to study the various physical methods of mineral dressing on a sufficient scale to enable satisfactory techniques to be developed and appraised. In addition, it is also concerned with improving the understanding of the theoretical aspects of the processes involved and developing new methods.

Among reactor materials which are being studied are graphite, beryllium and beryllia, all of which may be used as moderators, and are therefore required free from impurities which absorb neutrons. Small-scale equipment has been installed for making graphite from coke and pitch and for extruding graphite shapes, so that new methods of producing samples with higher purity and better mechanical properties can be investigated. Beryllium is an extremely toxic material, and a special laboratory has been built for working with it and its compounds. In addition to its possible uses in a reactor, beryllia is a useful refractory, and crucibles and other beryllia ware are being made for use in the Establishment.

New methods of chemical separation being studied include ion exchange, solvent extraction and chemical exchange. These are required for a wide variety of problems: for the separation of plutonium from uranium metal which has been irradiated in the pile; for the separation of the radioactive fission products, for example, for the separation of radioiodine for hospital use; and for the separation of hafnium from zirconium in order to produce pure zirconium metal for new reactors. The object of these studies is not only to prove the processes involved and produce small quantities of materials for further experiments, but also to improve design methods in the operations involved.

Chemistry

The first wing of the new radiochemistry laboratory was completed last summer, and since that time the laboratory has come into full occupation and about 90 per cent of its facilities are installed and working. The most important work carried out in the laboratory is research on methods of separating plutonium and fission products from uranium metal that has been irradiated in a pile, and the chemistry and chemical engineering divisions have made pilot-plant studies on the method which will be used in the full-scale production plant.

Certain special laboratories are equipped for extraction of plutonium from uranium rods with an activity of the order of 100 curies (that is, equivalent to 100 gm. of radium). For work with this amount of activity, laboratory equipment has to be shielded by about 4 in. of lead, built up from interlocking bricks, and materials must be manipulated behind the shield by remote control.

While a large part of the chemical effort is concerned with problems related to the technology of plutonium production, the chemical problems associated with piles and reactors have not been neglected. The effect of radiation on the chemical reactivity of pile materials, for example, has received attention, a typical example being the system formed by graphite and air coolant. The pile is also being used for more general investigations such as a study of the chemical changes occurring in certain organic substances when exposed to radiation and various radiochemical studies. One useful application is the method of radioactivation analysis. In this method, the sample to be analysed is irradiated in the pile and, after removal, the radiation from new isotopes which have been formed is observed. In suitable cases, depending on the nuclear properties of the substances involved, very small amounts of impurities can be detected in this way.

Metallurgy

The work of the Metallurgy Division ranges from fundamental research studies into solid-state phenomena to technological development of materials and processes of particular interest to atomic energy, such as plutonium, uranium and beryllium, and methods of fabricating them in the desired form.

Among the basic researches which are being undertaken are diffusion in metals, deformation by twinning, heavy-element alloy theory and effect of irradiation on solids. In the technological field a new method has been developed of producing uranium metal much more economically than was possible by existing techniques, and new designs have been produced of uranium rods cased in aluminium which will withstand higher operating temperatures.

A systematic study is being made of the properties of uranium alloys, partly in the hope of finding alloys with better chemical, physical and mechanical properties than the pure metal, and partly to increase theoretical knowledge of the principles of alloy formation, so that alloy behaviour can be predicted more accurately than is at present possible. For this work an argon-arc furnace has been developed in

Fig. 1. BEPO. Experimental face of the pile. The apparatus near the face includes a neutron spectrometer and a mechanical velocity selector. There is other experimental equipment on top of the pile. *Crown copyright reserved*

which the most refractory metals can be melted. The metals are melted without using a containing crucible, and this feature, together with the inert atmosphere, allows specimens to be prepared at very high temperatures without contamination.

As part of the study of the effect of pile radiation on the physical properties of metals, an air-flow extensometer has been made which measures small strains (less than 10^{-6}) in a sample exposed to radiation in a pile. In these conditions only remote methods of measurement are possible, as conventional methods might be disturbed by the pile radiation. The principle of the method depends on measuring the air flow between two parallel plates attached to the specimen. The 'impedance' to air flow of the plates is then compared with a standard in an air analogue of an electrical Wheatstone bridge circuit.

BEPO

BEPO, the larger of the two piles at Harwell, started up for the first time almost exactly two years ago—on July 3, 1948. The next few months were spent in measurement of the characteristics of the pile, and tests and calibration of associated equipment; the pile came into full use in early 1949, and the production of radioisotopes began in it in February of that year. Since that time BEPO (Fig. 1) has been in almost continuous operation.

Apart from the production of radioisotopes, the pile is being used for experiments in nuclear physics and radiation chemistry, and on the properties of materials of importance to the reactor programme. The work of the chemists on reactions occurring inside a pile has already been mentioned. It is also necessary to study the effects of pile radiation on the mechanical, electrical and thermal properties of possible reactor materials, and the results of some of this work are of interest to the solid-state physicist.

For nuclear physics experiments with the pile, the auxiliary equipment installed includes a mechanical neutron velocity selector and two crystal neutron spectrometers. Most of the work in this field is concerned with the nuclear properties of reactor materials, including nuclear fuels, and investigation of nuclear reactions for isotope production; but some fundamental research has also been carried out, including a search for the di-neutron.

Production of Power from Nuclear Energy

As a result of design studies and two years experience in the operation of the Harwell piles, a suggested programme of construction of experimental reactors for the production of useful power has been drawn up, and this programme is now being considered by the Government. The next step will be feasibility and further design studies on these reactors, in order to find out whether they are practicable, and to make some estimate of their cost: this may take perhaps a year in one case and two years in another. Then, provided approval is given for a building programme, it will take another three years to complete and gain some experience in the operation of the first machines. Until this stage is reached, it will be impossible to make reliable predictions about the economics of power production.

The main problems in this work are: first, to find economical methods of extracting uranium from low-grade ores, and as has been mentioned the Chemical Engineering Division is working on this problem; second, to develop nuclear reactors which will burn a much higher proportion of the initial charge of uranium metal than will existing reactors; and third, to find suitable materials which will withstand the higher temperatures necessary for economic use of the heat produced in the reactor.

Nearly all the facilities required for studying these problems have been completed, and some progress has been made. Two nuclear accelerators, the Van de Graaff generator and the linear accelerator, have come into use, and are beginning to provide the information on nuclear constants which is an essential foundation for the programme. The Metallurgy Division is studying possible new reactor materials, and encouraging progress has been made in the production of beryllium shapes. Another potentially useful metal is zirconium, but this is difficult to prepare in a sufficiently pure state: the Chemistry Division has worked out a promising method for doing this, which is capable of development on a production scale. Liquid metals may be used in new reactors, and the heat transfer problems at the very high transfer rates that would be required are being studied by the Engineering Division. The Engineering and Chemical Engineering Divisions are also studying the problems of circulating liquid metals in closed circuits.

Production and Application of Radioactive Isotopes

A small but intense effort is being devoted to making artificial radioactive isotopes, and production now exceeds five hundred samples per month, a figure at least comparable with production in the United States. The use of this valuable new research tool is increasing rapidly, particularly in medical and university laboratories, and in recent months there has also been some increase in industrial use. The

Isotope Division at Harwell maintains an advisory service to assist potential new users, and also showed some typical applications in the British Industries Fair.

Two applications that are being widely used are the measurement of the thickness of thin films by the attenuation of rays from a β-emitter, and the dispersion of static electricity. In the case of the former, several instruments made commercially are already on the market. Another promising application is the use of γ-emitters for industrial radiography, and several isotopes for this purpose are already available in standardized source sizes. The present aim is to find a range of sources covering the energy region from 200 KeV. to about 1 MeV., which would be suitable for radiographs of steels and light alloys from ½ in. up to 6 in. thick. Cobalt-60, with γ-ray energies of 1·1 and 1·3 MeV., tantalum-182 with an average of 1·125 MeV. and iridium-192 with an average of 0·5 MeV. all appear suitable, and other isotopes are being investigated.

It is sometimes forgotten that many of the artificially produced radioisotopes require chemical processing after they are taken out of the pile. Because of the short half-life of the most widely used isotopes, much of this processing has to be done at Harwell, including a production of phosphorus-32, iodine-131 and gold-198, each of the order of 1 curie per week; one suite in the new radiochemical laboratory is used almost entirely for this work.

Chemical processing of longer-lived isotopes, and syntheses of compounds with 'labelled' atoms, particularly carbon-14, are carried out at the Radiochemical Centre at Amersham, which became an outstation of the Establishment last April.

Particle Accelerators

The newest particle accelerator at Harwell, completed earlier this year, is a 4-MeV. linear accelerator, similar to the Malvern accelerator previously described[1]. It will be used principally for measuring the neutron cross-sections of reactor materials by the time of flight method. The accelerator produces pulses of electrons lasting 2 microseconds, with a beam current in the pulse of about 120 milliamperes. The electron beam strikes a heavy-metal target, so producing intense pulses of γ-rays. In this machine, the γ-rays are used to irradiate a beryllium target, which gives the neutrons required for experimental work.

Compared with other accelerators giving a similar output, the linear accelerator is both compact and cheap: because of these factors it is very suitable for deep X-ray therapy in hospitals, and some similar machines are to be built for this purpose.

The 175-MeV. synchro-cyclotron (Fig. 2), which started up last December[2], has continued to work remarkably well and is now available full-time for experimental purposes. Some interesting results have already been obtained with it, and these were the subject of a recent communication in *Nature*[3].

[1] *Nature*, **162**, 859 (1948).
[2] *Nature*, **165**, 90 (1950).
[3] *Nature*, **165**, 967 (1950).

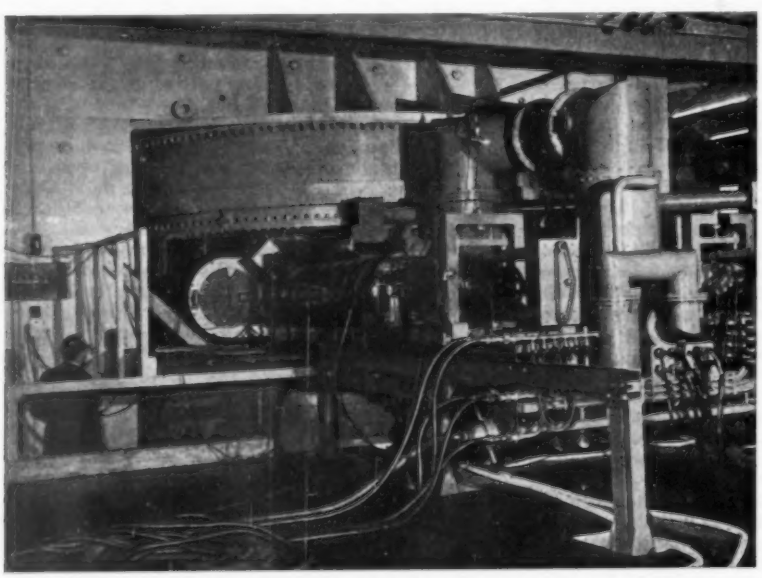

Fig. 2. 175-MeV. synchro-cyclotron at Harwell. The accelerating voltage is fed into this side of the machine from a radio-frequency transmitter. *Crown copyright reserved*

FOURTH WORLD POWER CONFERENCE

THE World Power Conference, founded in 1924, has held plenary meetings in 1924 (London), 1930 (Berlin) and 1936 (Washington). Although sectional meetings have been held in intermediate years, including one at The Hague in 1947 on the subject of fuel economy, the Second World War caused a gap in plenary meetings after the Washington meeting extending until this year. The Fourth World Power Conference was held in London during July 10–15, under the patronage of Princess Elizabeth and the Duke of Edinburgh. The theme was "World Energy Resources and the Production of Power". The Conference, which was attended by representatives of more than forty nations, was opened by its president, Sir Harold Hartley, in the presence of a distinguished company, including representatives of the Governments of many of the nations represented. For discussion within four working days, the gathering had before it 155 papers and 19 general reports, each of which dealt with one of the sections into which the papers were divided.

There is anxiety throughout the world concerning reserves of energy. The demand for electricity has increased of late years at an exponential rate, and if the demand for coal, oil and gas has more nearly followed a straight-line law, the slope of the line has

been such as to cause concern among individual nations as to when their own supplies of fossil fuels will become exhausted, and to the world in general as to possible sources of energy when there is no more coal or oil. Our present civilization is built on harnessing artificial sources of power to human needs; the greater the productivity, the greater the consumption of coal and oil. The statement was made that if in Britain the same amount of power was used per head of population as in the United States, the whole of the country's present coal output would be needed to generate the electricity required.

In consequence of this position, there is the greatest activity all over the world to eke out coal reserves by using other sources of energy. Many nations, among whom are the Norwegians, the Swedes, the Canadians, the Finns, the Poles, the Austrians, the Portuguese, the French, the Swiss, and even the Americans, are developing their indigenous sources of water-power; in many of these lands this meets most of the energy requirements. Other ideas are finding practical expression. There is a project at Abidjan on the Ivory Coast for using the potential thermal energy of sea-water existing by reason of the vertical temperature gradient of 68° F. or more over a depth of 1,640 ft. in tropical seas; a boiler heated by water at a temperature of 82° F. would supply a turbine with steam at a corresponding pressure exhausting into a condenser cooled by water at 46° F. A unique hydro-electric scheme is proposed in North Africa whereby the waters of the Mediterranean would be admitted to the Qattara Depression, providing some 300 MW. of hydro-electric capacity, the incoming water being disposed of by natural evaporation from the salt lake formed in the Depression. At Lardarello, in Italy, there is what the general reporter described as "a unique and epic achievement in engineering history" in which natural steam at 15–18 atm. and 285–420° F. is obtained, mixed with gases, from underground molten volcanic magma by putting down boreholes, up to 10,000 ft. in depth, capping them like an oil gusher when the initial eruption has quietened somewhat, and expanding the steam through turbines; since 1949, power production from this source has been at the rate of more than 1,000 million kWh. a year, and makes an important contribution to satisfying Italy's energy requirements. Wind-power and atomic energy are also under investigation. The planned international development of rivers by mutual agreement for the advantage of all nations through whose territory they flow was generally approved, the uses including power, irrigation, fishing and transport. Fuel economy is being scientifically pursued by all industrial nations; but one important source of waste appears to be virtually untouched—avoidance of loss of coal underground. The coal lost in mining bituminous coal in the United States, as an example, is generally cited as 34·7 per cent, a figure published by the U.S. Bureau of Mines twenty-five years ago, with the comment that more than half these losses were avoidable; present opinion is that this loss has since risen, perhaps to 50 per cent.

In 1924, British coal reserves were estimated as 137,166 million metric tons, which on an output of 200 million tons a year seemed comfortably sufficient for 685 years. The Regional Survey Committee of the Ministry of Fuel and Power in 1945 arrived at a total reserve of 44,714 million metric tons, plus some explored but probable additional reserves. If this estimate does not allow for mining losses, Great Britain's resources may be sufficient for not much longer than 150 years. Hydro-electric resources of the British Isles can provide only a modest proportion of the total energy requirements of the population. In 1948 the output of hydro stations under the British Electricity Authority was 517 million kWh. It is believed that a total of about 12,000 million kWh. could be generated in Scotland and a further 2,365 million kWh. from a Severn barrage. A total of 20,000 million kWh. appears to be the limit in the present state of knowledge. This is less than half the electricity distributed through the public supply in Great Britain in the year ending March 31, 1949, and thus corresponds to about one-tenth of the country's coal consumption. The British Electrical and Allied Industries Research Association and the North of Scotland Hydro-Electric Board have arranged for the erection of a 100-kW. wind-driven generator in the Orkneys as a pilot plant.

The oil industry provides a striking example of conservation of existing resources and of discovery of new reserves more than keeping pace even with present-day leaping requirements. Technical skill has overcome the challenge of maintaining supplies at a level that has met unprecedented demands. The depth from which oil is obtained has increased from 2,314 metres in 1925 to 6,270 metres. The submerged sea areas bordering the North American continent represent an "assured source of large quantities of petroleum". Drilling and production practice has been greatly improved. One most important advance has been the development of reservoir engineering with the object of so guiding the exploitation and operation of oil reservoirs as to achieve maximum recovery at minimum cost.

The production of energy from nuclear fission is exercising keen minds, at great cost, in many lands. The method visualized is the transfer of heat from a nuclear reactor through a suitable medium (helium under pressure being favoured at present) to the boiler unit of a conventional power-generating system. Nuclear reactors must be devised which will develop heat at a temperature high enough to produce high thermodynamic efficiencies; the reactors must utilize nuclear fuel efficiently; the reactor life must be long enough to keep interest and depreciation charges to a reasonable level; overall operating costs, including costs of providing and processing nuclear fuel, must be comparable with costs of power stations of conventional design. Among the more important scientific factors is the need to 'breed' more secondary nuclear fuel within the pile than primary fuel consumed; a difference of opinion was observed at the conference on the extent to which this can be done at present. Engineers asked pertinent questions on the stability of constructional materials under pile conditions, since the whole of the plant must be within a protective casing. Existing power plant requires frequent inspection and maintenance; it is asked how the problems of lubrication and maintenance can be overcome under atomic-pile conditions, where both circulating system and prime mover are inaccessible. Reactors under construction in the United States and Britain are expected to provide information on the many scientific and engineering problems involved; but an American author confessed that the technical problems in power generation from nuclear fission "are proving to be more difficult than was expected three years ago".

The sections dealing with the preparation of solid fuels discussed coals, sub-bituminous coals and peat,

and coke. Modern mechanical coal mining is bringing to the surface material containing a greater proportion of dirt and a larger quantity of fines. The use of water underground for dust suppression seems likely to cause the total disappearance of dry-cleaning systems. New wet-washing methods, such as dense-medium processes and froth-flotation, combined with older established methods now enable any size of coal to be cleaned; the immediate problem in many countries is to erect suitable and sufficient coal-cleaning plant at a reasonable cost and in reasonable time. How far fines should be cleaned and how far they should be used in the uncleaned state for powdered-fuel firing remains a difficult economic question. The tendency in Britain is to erect large central washeries. Coal cleaning is becoming a specialist subject. The National Coal Board has adopted a practical classification of British coals based on rank, yield of volatile matter and coking property, and has brought into use the standard size grading of the former British Colliery Owners' Research Association, in which only seven sizes above ¼ in. are recognized for marketing purposes. There is a difference of opinion between nations possessing peat deposits as to whether the winning of peat is economical; the utilization of peat is under examination in several countries. Brown coals and lignites, which were extensively developed in Germany, are now being used for boiler firing in Australia, Czechoslovakia, Yugoslavia and elsewhere, and efforts are being made to dry and briquette it economically or to carbonize it.

All nations possessing coking coals are finding that their reserves of good coking coals are running low. Research is being undertaken on the use of the poorer coking coals for making blast furnace coke. Fine grinding of the coals, blending of coking with poorly coking or non-coking coals or with semi-coke, and two-stage processes often involving pre-carbonization followed by briquetting and re-carbonization are favoured. Economics, including cost of transport and manufacturing costs, dictate which, if any, of these processes can be used, even when they are technically sound. The possibility is envisaged of devising a low-cost method of iron-making that does not require hard coke.

Advances in the petroleum industry have been due to increasing demand for gasoline both in quantity and quality. Catalytic cracking is replacing thermal processing. The low efficiency (6 per cent) of gasoline used for transportation has led to increased engine compression ratio, which in turn necessitates gasoline of much higher octane number—an expensive matter—as an alternative to which manufacturers are endeavouring to improve the efficiency of the use of gasoline, for example, by a small super-charged engine, together with after-cooling, an exhaust gas turbine, and an automatic transmission. The application of chemical synthesis is a feature of the modern petroleum industry, including polymerization, alkylation, isomerization, superfractionation, catalytic cracking and hydro-reforming. Synthetic production of liquid fuels from coal, brown coal, etc., is being intensively studied; but these processes are only likely to be used industrially when supplies of natural oil become less than demand. The view was expressed that ultimately coal would be used solely as the raw material for the manufacture of oil for the internal combustion engine, other sources of energy being developed to replace coal for its present uses.

Natural gas—once largely wasted—is now making an increasingly large contribution to energy requirements both in America and Europe. It is used as fuel for industrial and domestic purposes, in the compressed state as a substitute for gasoline, as raw material for manufacture of chemical products and of synthesis gas for synthetic liquid fuel production, and as a source of hydrogen for synthetic ammonia manufacture. Interest is being taken in the recovery of methane from coal seams, partly to reduce the fire-damp concentration in gassy mines.

There is increasing use in many countries of the lower grades of fuel in large steam-raising units; this leads to problems of boiler availability and size, of ash and grit disposal, to increased capital cost and possible reduced efficiency. Pulverized fuel firing is favoured, largely because of its flexibility, for larger boilers; but it has limitations with low-volatile coals. High steam pressures and temperatures, for example, up to 2,133 lb./sq. in. and 968° F., are ranked high among means of securing greater economy; in Britain, 81 per cent of the new plant is designed for two standard conditions: 600 lb./sq. in., 850° F. and 900 lb./sq. in., 900° F.; some new British plant will operate between 1,235 lb./sq. in., 825° F. and 1,500 lb./sq. in., 1,050° F. The Americans have plants running with steam at pressures of 1,800 and 2,000 lb./sq. in. and many plants are designed for steam at 1,050° F. These conditions are permitted by the use of newer steels, mainly ferritic, with greater high-temperature strength. There is a tendency to use larger turbo-generators and larger boilers; in Britain, many 60-MW. and a few 100-MW. machines are under construction. In the United States, the trend towards the single boiler-turbine combination has involved steaming capacities up to 1,370,000 lb./hr. The higher capital charges involved in burning low-grade fuels have been mitigated by more suitable design supplemented by better methods of on-load cleaning. The cyclone furnace has increased in popularity when the ash-fusion temperature of the fuel has been suitable. Spreader stokers are increasingly used for lower capacities. The natural-circulation boiler seems to hold its own over forced-circulation and other competitors. Greater use is made of re-heat. Series of papers discussed the design of turbines and auxiliaries, and the use of fuels other than coal for steam-raising, for example, wood, brown coal, peat, town refuse and vegetable waste.

The wide variety of uses to which the gas turbine is put were reflected in the interest aroused by the discussion. Its future utilization depends on its ability to burn cheap fuel, and in all countries the development is towards using as gas turbine fuel coal or residual oil, and, in Britain, peat. Deleterious gaseous matter may cause difficulties, and it is not yet certain whether the largest size of particle which can be permitted to reach the turbine blades is 10 μ or as high as 20 μ. Exhaust gases from high-temperature processes can be used for power generation, and the turbine can supply as exhaust low-temperature gases for drying, or pre-heated air for furnaces. The open cycle is generally adopted; but many believe that more emphasis should be put on the closed cycle. A second noticeable feature is the almost universal adoption of the axial-flow compressor. The gas turbine is clearly still in a comparatively early stage in its development; we cannot yet design a machine to run successfully and consistently on any given fuel.

G. E. Foxwell

NEWS and VIEWS

Veterinary Medicine at Cambridge: Prof. L. P. Pugh

THE appointment of Leslie P. Pugh to the newly established professorship of veterinary clinical studies in the University of Cambridge marks a further important development in the building up of the School of Veterinary Medicine at Cambridge. Prof. Pugh graduated from the Royal Veterinary College in 1917 and took his B.Sc. in the University of London in the same year. Since the end of the First World War he has been in practice at Sevenoaks. Prof. Pugh obtained the fellowship of the Royal College of Veterinary Surgeons for a thesis on bovine sterility in 1923. He was a pioneer in work on sterility of cows, using methods that have only in recent years been generally adopted. Later, in collaboration with laboratory workers, Prof. Pugh made important contributions to the study of leptospinal jaundice in dogs, he being the first to recognize this disease in dogs in the United Kingdom. More recently his interest has been directed mainly to the complex problem of virus infections of the central nervous system of dogs. Prof. Pugh, who is regarded by his professional colleagues as an outstanding clinician, has managed to carry on clinical research at the same time as conducting a very successful practice. His new appointment will give him opportunities of pursuing his research with greater facilities as well as passing on his knowledge and skill to others. He takes up his new appointment in January 1951.

Polarographic Institute, Prague

ON June 20 the Czechoslovak Government founded by decree a number of central research institutes, covering mathematical, physical, astronomical, chemical, geological and biological studies, which will come under the State Planning Office. Among these new bodies is the Polarographic Institute, the director of which is Prof. J. Heyrovský, who is now leaving the Ministry of Education and the Physico-chemical Institute in the Faculty of Sciences, Charles University, Prague. Prof. Heyrovský remains an honorary professor in the University and continues to lecture there. The aim of the Polarographic Institute is to foster polarographic methods for pure and applied science, to concentrate all documentation and bibliography in its library and to promote polarography by practical courses and lectures. There is room for eighteen scientific staff and seven administrative staff; in addition, visiting students are welcomed. The Institute is provisionally in a flat containing ten rooms in a building where research on metals is concentrated (Prague II, Opletalova 5); but larger accommodation is being sought. The present staff numbers fourteen, including the director and Dr. J. V. Novák (vice-director), known from his numerous papers on polarography.

School of Gas Turbine Technology

POWER Jets (Research and Development), Ltd., announce that the School of Gas Turbine Technology is re-opening at Farnborough Place, Farnborough, in October. Operated at first by the National Gas Turbine Establishment, the School was taken over in 1948 by Power Jets (Research and Development), Ltd., a nationally owned company, which is responsible for the exploitation of a large number of British patents covering gas turbine technology and design. The School has been moved, because of expansion, from its old premises at Lutterworth. Founded in 1944 to instruct Dominions' Air Force personnel in aircraft jet engines, the School now gives theoretical and practical instruction in the use of gas turbines in high-speed aeroplanes, locomotives, road vehicles, ships, power stations, process power and other industrial applications. There will be four different types of courses, one of which is an international course designed specially for overseas engineers. Particulars of courses can be obtained from the Principal, School of Gas Turbine Technology, Farnborough Place, Farnborough, Hants.

Display of Early Herbals in Edinburgh

THERE have been placed on view in the Upper Library Hall of the University of Edinburgh, primarily to illustrate a lecture to the history of medicine class, but also to interest a wider audience, a number of early herbals, pharmacopœias and works on domestic medicine from the University Library. In the collection are two copies of that pioneer of herbals, the "Hortus Sanitatis", printed at Strassbourg in 1497, crudely illustrated, but widely used in its day. A much higher standard of draughtsmanship is apparent in the lovely "Herbarium Vivæ Eicones", first published by Otho Brunfels in 1530, and it was maintained in the later works of Leonhard Fuchs, who gave his name to the *Fuchsia*, and of Lobelius, from whom *Lobelia* is named. In 1569, Monardes of Seville described many new vegetable remedies from America; his book contains the first printed illustration of the tobacco plant. William Turner, dean of Wells, is often regarded as the 'father' of English botany. The herbal which Turner dedicated to Queen Elizabeth was followed by the works of John Gerard, who grew potatoes in his garden in Holborn, and of John Parkinson, who entitled his book "Paradisi in sole" (park in the sun), and who was perhaps the last of the great English herbal writers. There is also on view a handsome copy of Elizabeth Blackwell's "Herbarium", in three volumes, containing a curious drawing of the Scythian Lamb, half animal, half vegetable. Among the pharmacopœias is the unique copy of the first edition (1699) of the Pharmacopœia of the Royal College of Physicians of Edinburgh, kindly lent by the College, while domestic medicine is represented by several Gaelic manuscripts, and by one of the first printed books of this class, entitled "The Poor Man's Physician, or the Receits of the famous John Moncrief of Tippermalloch", dated 1712. Copies of those very popular guides, John Wesley's "Primitive Physic" (1747) and William Buchan's "Domestic Medicine" (1769), are part of the exhibition, which has been described and annotated in a booklet prepared by Dr. Douglas Guthrie, with the collaboration of Dr. Sharp, Dr. Corson and Mr. Finlayson, while the photostencil illustrations are the work of Mr. R. J. Mackay.

Anthropology and Genetics

THE fifteenth symposium of the Long Island Biological Association on Quantitative Biology was held at the Biological Laboratory, Cold Spring Harbor, New York, during June 9–17. Each year a biological subject is chosen which is susceptible of quantitative treatment, and speakers are invited who have investigated the subject from as many different angles as possible. The subject of this year's papers and discussions was "The Origin and Evolution of Man". The programme was planned by Dr. M. Demerec, director of the Laboratory, in consultation

with Prof. Th. Dobzhansky and Prof. S. L. Washburn. The first day was devoted to population genetics; and then followed a consideration of man's origin and evolution from the morphological point of view. The next subject was the genetical analysis of racial traits, such as blood groups and other normal and pathological human characters. The concept of race and racial types was next considered, and then the question of individual constitution and the correlation of the morphological type of the individual with physiological and psychological characters. The last day was devoted to a general summing-up and a consideration of the possibilities of future research. One suggested proposal made earlier in the symposium by Prof. S. L. Washburn was the institution of a science of experimental anthropology, based upon the study of lower primates. As an example of what might be achieved, he instanced the effect of the ablation of muscles in preventing the development of major external features of the skull. The main purpose of this symposium was to bring together anthropologists and geneticists, and this it achieved most happily. The effect of this 'cross-pollination' remains to be seen; but it may well represent a notable landmark in the science of anthropology.

Planning and Production Costs in Great Britain

In a brochure issued by Political and Economic Planning (16 Queen Anne's Gate, London, S.W.1) entitled "Economic Policy: a Discussion of Planning Techniques", it is pointed cut that for many years government after government in Great Britain has been playing an increasing part in economic affairs. The first post-war government found ready to hand a machine of control left over from the War. There were great post-war demands for capital and consumer goods, limited resources of equipment, labour and materials to meet the demands, and the consequent danger of severe inflation; the mechanism of world trade had been thrown off its balance, and it was necessary to change over from war to peace production. All these problems demanded policies not fundamentally different from those of war. Controls were therefore preserved; but, as conditions improved, they were gradually relaxed and in part abandoned. The main tasks of planning are now in connexion with costs. If overseas markets are to be held, costs must be reduced; if internal stability is to be maintained, they must be reduced without deflation. The volume of industrial production has not risen quite enough to cover both the increased consumption and increased capital expenditure of the past five years—in other words, production costs are too high. The crucial problem is how to get the two sides of the equation to balance. It is a problem involving more than monetary policy; it is also a psychological problem and one of organisation.

Atmospheric Pollution and Smoke Abatement

The National Smoke Abatement Society, which was founded in 1929, 'comes of age' this year, and its Spring Number (No. 73; 1950) is set out to direct attention to the achievements in twenty-one years. After a modest growth in ten years, the Society expanded rapidly during the period of the Second World War. The Spring Number contains interesting articles on current fuel practice in Great Britain and in the United States; probably the most interesting are those dealing with the influence of atmospheric pollution on public health. Thus the medical officer of Burnley, Lancs, compares blood tests on women in Burnley showing 75 per cent of red blood corpuscles with corresponding tests in Denmark where 100 per cent was found, and the difference is ascribed to the variation of atmospheric pollution. Such observations tend to give the impression that smoke is a nuisance which is undesirable but possibly to be tolerated. The contents of this Spring Number contains evidence that the results can be much graver, leading to numbers of fatal results. In 1948, in Donora, a small industrial town of fourteen thousand inhabitants in Pennsylvania, there was an attack of smoke and fog such as to cause the death of twenty people within twenty-four hours. Investigation on a national scale put the cause down to a combination of circumstances (partly topographical as the town lies in a valley which is long and narrow); the weather was still, cold and anticyclonic; and local industry was concerned with heavy steel work with the consequent production of sulphurous products of combustion. These conditions recall similar experiences in 1930 at Liège in the Meuse Valley. The same results are conceivable in Great Britain under extreme conditions, and the only prevention would be the avoidance of atmospheric pollution.

Primates at the British Museum (Natural History)

A guide to the fossil remains of man in the Department of Geology of the British Museum (Natural History) was written by the late Sir Arthur Smith Woodward and appeared in 1915. Although it reached a third edition in 1932, it has been out of print for some years. In the meantime, new discoveries in Africa, Asia and Europe had so enlarged the picture of man's early evolution that a fresh approach was essential, and the preparation of a new guide was undertaken by Prof. W. E. Le Gros Clark. This was published a year ago; but the demand has been so heavy that a second edition has been prepared. In this, after sketching the background of the principles of classification and evolution, Prof. Le Gros Clark treats the history of the group of primates, both living and fossil, in such detail as will enable the student to appreciate the evolutionary aspects of the origin of man. The implements and culture of early man, however, which played such an important part in his subsequent development, are dealt with in a separate guide, "Man the Tool-Maker", by Dr. K. P. Oakley. Copies of the guides may be obtained from the Museum, price 2*s*. 6*d*. each.

Anniversaries of Famous Chemists

A number of the *Proceedings of the American Academy of Arts and Sciences* (78, No. 1; 1950) is devoted to short biographies of chemists and summaries of their work in twenty-seven cases in which the centenary or polycentenary of the date of birth or death falls in the year 1950. These biographies have been prepared by Prof. E. H. Huntress. Among them are outstanding personalities such as Brühl, Gay-Lussac, Dumas, Wöhler and Hess; such names as D. Bernoulli, Heaviside and K. F. Braun are also included, although they were not chemists. References to periodical literature containing portraits and photographs are given. Of the individuals treated, nineteen are 100-year anniversaries, five are 150-year memorials, while the remaining three represent celebrations of 250, 300 and 400 years, respectively. The notices are detailed enough to be useful and interesting, references being given for the outstanding contributions of the persons concerned.

Manchester Museum : Annual Report for 1948–49

THE annual report of the Manchester Museum for the year ending July 31, 1949 (pp. 24 ; Manchester : the Museum, 1950), records that the period under review was a notable one in the history of the Museum. This was not so much on account of any remarkable progress made during the year, but because of various long-term policies that were initiated. During recent years shortage of staff and lack of money have been serious handicaps. The improvement of finance—chiefly due to the increase of annual grants from the City and the University—have made it possible for the committee to increase the staff in several directions. This increase of staff —professional, administrative and technical—is already reflected in increased activity in the exhibition galleries, overhaul of reserve collections, carrying out of various works of conservation, publishing literature relating to the collections, and in advancing scientific research. All these are major functions of a museum, and it is gratifying to record that the Manchester Museum is placing its increased income to these purposes.

Biological Indicators in the Northern North Sea

MARINE animals, the distribution of which is limited to oceanic water-masses of defined characters, may be used for indicating the movements of such water-masses into other areas. As 'biological indicators' they may provide powerful tools for the physical oceanographer. Salps and doliolids may be so used for indicating Atlantic oceanic water intruding on to the Continental Shelf. In a publication of the Scottish Home Department, Fisheries Division, entitled "Scientific Investigations, 1949, No. 1 : The Distribution of Thaliacea (Salps and Doliolids) in Scottish Waters, 1920 to 1939" (pp. 44 ; Edinburgh and London : H.M. Stationery Office, 1949 ; 2*s.* net), Dr. J. H. Fraser has examined plankton hauls taken over a period of twenty years by Scottish research vessels and has produced evidence of much value to the physical oceanographer and fisheries naturalist. The numbers and distribution of salps and doliolids in the northern North Sea have varied much from year to year and accord with the hydrographical observations. Influxes of Atlantic water are variable and do not occur in Scottish waters when there are large influxes into the English Channel and vice versa.

Clayton and Manville Fellowships and Grants

UNDER two bequests, the Clayton Bequest and the Manville Bequest, the Institution of Mechanical Engineers has made the following awards for post-graduate training, experience or research in mechanical engineering, for research at the places mentioned : *Clayton Fellowships*, 1950 : J. Halling (Imperial College of Science and Technology, London, on "Rolling Friction with Special Reference to Surface Finish") ; E. P. Hotchen (College of Technology, Manchester, on "The Measurement of Flue Gas Temperatures") ; John Houghton (Queen Mary College, London, on "The Effect of End Constraint on Thin-walled and Solid Cylinders of Hyperbolic Aerofoil Shape") ; R. V. Macbeth (King's College, London, on "The Combustion of Oil Fuels") ; G. Moss (King's College, London, on "A New Form of Continuous Filter") ; F. Ellis (Imperial College of Science and Technology, London, on "Certain Aspects of Hot and Cold Rolling by Photo-elastic and Other Methods"). *Manville Fellowship and Clayton Grant*, 1950 : B. Mills (University of Birmingham, on "The Flow of Gas Through Poppet-type Exhaust Valves at Subsonic and Supersonic Velocities"). *Clayton Grants*, 1950 : E. Harvey (Imperial College of Science and Technology, London, on "A Method of Jet Propulsion for Marine Application") ; H. C. Barty (for development of "Damping Devices for Road Vehicle Suspension").

Announcements

IN connexion with the International Congress of Anatomists, meeting at Oxford, the University of Oxford has conferred the honorary degree of D.Sc. on Prof. George W. Corner, director of the Department of Embryology, Carnegie Institution of Washington, Prof. W. M. Woerdeman, professor of embryology in the University of Amsterdam, and Dr. L. S. B. Leakey, curator of the Coryndon Memorial Museum, Nairobi.

MR. W. A. ROBERTSON, forestry adviser to the Secretary of State, will be retiring from his present post at the end of this year, and Mr. F. S. Collier, at present chief conservator of forests, Nigeria, has been appointed to succeed him. Mr. Collier will take up his duties in the new year.

THE annual conference of Aslib (incorporating the Association of Special Libraries and Information Bureaux and the British Society for International Bibliography) will be held in the University of Bristol during September 22–25. Further information can be obtained from the Secretary, Aslib, 4 Palace Gate, London, W:8.

A SYMPOSIUM on the techniques of subjective appraisal is to be held in London on October 14. The programme is to be divided into two main topics : (*a*) stimulus-sensation relationship ; (*b*) the subject as an assessor of sensation. The organisation is in the hands of a committee consisting of Dr. D. W. Fry, Department of Phonetics, University College, London, Prof. R. C. Oldfield, University of Reading, and Dr. R. G. Hopkinson, Building Research Station, Garston, Watford, Herts (*secretary*) ; further information can be obtained from Dr. Hopkinson.

A TWO-DAY joint meeting has been arranged by the Edinburgh Section and the Fine Chemicals Group of the Society of Chemical Industry, to be held in Edinburgh during October 6–7. The programme includes an address by Dr. F. Bergel, chairman of the Fine Chemicals Group, on "The Biological and Therapeutic Significance of Organic Phosphates occurring in Nature" ; and the third Lister Lecture of the Society, to be delivered by Prof. G. F. Marrian, professor of chemistry in relation to medicine in the University of Edinburgh, under the title of "The Adrenocortical Hormones". Further particulars can be obtained from the honorary local secretary of the Edinburgh Section, Mr. G. W. Walker, c/o T. and H. Smith, Ltd., Wheatfield Road, Edinburgh 11.

WELLCOME PHARMACEUTICAL RESEARCH FELLOWSHIPS of £350 each for one year have been awarded to the following : Miss M. Dawson, for research at the School of Pharmacy, Royal Technical College, Glasgow, where she is on the staff, on the properties of pyrogenic substances ; Mr. J. R. Hodges, for work at the School of Pharmacy, University of London, in pharmacology ; and Mr. G. P. Lewis, for research at the Welsh National School of Medicine, into the properties of a group of newly synthesized antihistamine compounds.

OCCURRENCE OF A PHOSPHORIC ESTER IN CERTAIN BACTERIA: ITS RELATION TO GRAM STAINING AND PENICILLIN SENSITIVITY

By PETER MITCHELL and JENNIFER MOYLE
Sir William Dunn Institute of Biochemistry, Cambridge

THE methods of Gram staining at present in use vary only in detail from that originally discovered by chance and described by Gram[1] sixty-six years ago. They rely upon three essential processes. The organisms are allowed to adsorb Crystal Violet (444-tris-dimethylamino-triphenylmethane) or one of its homologues from a concentrated aqueous solution at about *p*H 7 for about a minute. Adsorption equilibrium is nearly achieved, and whether Gram-positive or Gram-negative, the cells take up a weight of dye amounting to 10 per cent or more of their dry weight. The stained cells are 'mordanted' by treatment with an aqueous solution of iodine in potassium iodide, or of any one of a wide variety of substances (picrates, chromates, trinitrobenzoates) forming salts with Crystal Violet which, like the complex iodide $(C_{25}H_{30}N_3\,I + I_2)$[2], are almost insoluble in water but sparingly soluble in neutral organic solvents such as acetone or alcohol. The stained, mordanted preparation is washed briefly in alcohol or acetone. The organisms from which the stain is rapidly eluted by the organic solvent are called Gram-negative, whereas those from which a small proportion is eluted only very slowly are called Gram-positive.

The longer retention of a portion of the stain by the Gram-positive organisms has generally been considered to be due to the presence of a special component, and opinion has been more or less equally divided as to whether this component is a chemical substance which adsorbs the stain specifically, or whether it takes the form of a physical barrier to the outward diffusion of the stain. The main evidence in favour of retention by a physical barrier came from the observation that the capacity for retaining the Gram stain was destroyed if the cells were mechanically ruptured[3]. But the weight of this observation was largely lost when it was shown that if the autolysis and dispersion of the cell contents which follow mechanical rupture are prevented by previous heating or other fixation methods, the cells do not lose the dye-retaining property[4]. Presumably, the movement of the stain from some matrix in Gram-positive cells is retarded, either because of the high affinity of the stain for the components of the matrix, or because of its low rate of diffusion out of the matrix, or because of a combination of both factors.

It was shown by Deussen[5] that when yeast cells underwent partial autolysis or if they were extracted with mineral acids or alkalis they became Gram-negative. He expressed the opinion that the nucleic acid recovered from the cell extracts was responsible for the Gram staining because, if the extracted Gram-negative cells were treated with the nucleate recovered from the extracts, they could be made Gram-positive again.

Deussen's view was contested by Schumacher[6] on the grounds that much of the nucleic acid could be extracted from the yeast cells in 2*N* hydrochloric acid without destroying their Gram-positive character; but the cells could be made Gram-negative by subsequent extraction with lipid solvents in the presence of mineral acid. Schumacher believed that the component which retained the stain was a lipoprotein; for cells which had been made Gram-negative by acid and lipid solvent extraction were found to recover the dye-retaining property when treated with the ether-soluble Gram-positive phospholipids obtained from the cells by the extraction procedure. The possibility of the participation of lipids in Gram staining had already been suggested by some of the first research workers in this field[7], who observed that Gram-negative cells could be made Gram-positive by plating them with lecithin.

With the studies of the Stearns[8] on the effect of *p*H upon the retention of the stain in the Gram technique, a good case was built up for believing that the positively charged stain was ionically bound, and attention was again focused upon the strongly negatively charged cell constituents. Following a report by Dubos[9] that the loss of the capacity for retaining the Gram stain in autolysing pneumococci occurred more or less concomitantly with the appearance of ribonucleic acid and ribonucleoprotein in the autolysate, Stacey and others[10] suggested that the essential component responsible for Gram staining was magnesium ribonucleate. They observed that after the dye-retaining property of certain Gram-positive organisms had been destroyed by autolysis or by extraction with sodium cholate, it could be restored by adsorbing magnesium ribonucleate upon the damaged cells—a now familiar but not altogether conclusive experimental device; for although the staining of a 'reconstituted' organism may be largely due to the material adsorbed upon the damaged cell, the Gram-positive character of the normal intact organism is not necessarily due to the same cause. We have recently found that particles of the order of 1 μ in diameter made of the weakly acidic gel obtained by treating gelatin with formalin stain intensely Gram-positive. Evidently acidic lipids, acidic protein and nucleic acids are all capable of retaining the Gram stain under appropriate conditions[11].

A somewhat different approach to the problem of the Gram stain was described by Gutstein[12], contemporary with the work of Schumacher. He investigated the nature of the site of stain absorption by determining the affinity of the site for a number of acidic, basic and lipid soluble dyes, and for acidic and basic mordants. The conclusion reached was that the Gram stain is taken up by a cortical layer which is special to Gram-positive cells. This layer consisted, he believed, of a basic ground substance, holding an acidic component that could be stained with Victoria Blue after extracting the nucleoprotein. The Gram staining was attributed to the acidic cortical component.

Attention had previously been directed to the difference in the nature of the external margins of

Gram-positive and Gram-negative organisms by observations on their digestibility by proteolytic enzymes and the sensitivity of the organisms to lysis in alkali. Kantorowicz[13] found that although all the organisms which he studied were resistant to pepsin and trypsin if undamaged, the Gram-negative group became susceptible to lysis after some change had occurred to the surface following heating to 70° C. In the following year, it was shown by Kruse[14] that the wall of Gram-negative cells is broken by dilute sodium hydroxide (*N*/10) and the cells lyse, whereas the Gram-positive wall is resistant. The observations of these two workers were afterwards confirmed and extended by Smith[15]. More recently, Bartholomew and Umbreit[16] found that crystalline ribonuclease will cause the loss of the Gram-positive staining character of a wide variety of heat-treated Gram-positive organisms, and they considered that a superficial part of the ribonucleic acid must be responsible for the staining reaction of Gram-positive cells. A similar conclusion was reached by Webb[19] from studies of the specific lytic action of lysozyme.

If the retention of the Gram stain is due to the presence of a particular substance, this substance would be expected to occur in much larger quantities in Gram-positive than in Gram-negative organisms. Jobling and Petersen[17] found that the lipids extracted from some Gram-positive bacteria differed from those of Gram-negative bacteria in that the former often gave larger iodine numbers and presumably contained a larger proportion of unsaturated fatty acids; but the differences were not large, and varied widely with the nature of the medium on which the organisms were grown. According to Schumacher[4], the lipoprotein responsible for the Gram staining of yeast gives on acid hydrolysis a Gram-positive "nitrogen free, phosphoric acid containing unsaturated fatty acid" which cannot be obtained from Gram-negative organisms. So far as we are aware, these observations have not been further elaborated. In a recent review by Stacey[18], it was stated that "the ratio of the relative amounts of the two types of nucleic acid differs in some Gram-positives from that in some Gram-negatives. Thus, in *Cl. Welchii* and streptococci, the ribo deoxyribotype is greater than 8/1, while in *Bact. typhosum*, *B. Shigæ*, *B. proteus*, etc., it is 1·3/1." But experimental values were not quoted in support of this view. We have made some measurements on the nucleic acid and associated fractions of a number of Gram-positive and Gram-negative organisms which do not show any marked systematic differences in the ratio of ribonucleic acid to desoxyribonucleic acid for the two groups of organisms, the value of this ratio generally being about 4/1, as shown in the accompanying table. Nevertheless, our observations appear to be relevant to the problem of the Gram stain, and may account for measurements of the ribonucleic acid content of Gram-positive organisms being erroneously high.

Comparison of the ultra-violet absorption at 260 mμ with the organic phosphorus content of the Schmidt and Thannhauser[20] 'ribonucleic acid' fraction of *Micrococcus pyogenes* var. *aureus* indicated that there was about 30 per cent more phosphorus than could be accounted for on the basis of a tetranucleotide structure[21]. A substantial part of the excess phosphorus has now been traced to a particular phosphoric ester (*XP*). This ester accounts for more than 20 per cent of the total phosphorus of *Mic. pyogenes*.

A survey of a small group of Gram-positive and Gram-negative organisms has been made in order to discover whether this phosphoric ester is a component special to Gram-positive cells. All the organisms studied were grown in the same medium and harvested at the approach to the stationary phase except where otherwise indicated. The ultra-violet estimations of ribonucleic acid as micromoles of purine-pyrimidine per gram dry weight (mean molar extinction coefficient 8,200) and organic phosphorus as micromoles per gram dry weight in the 'ribonucleic acid' fraction are shown in the table. The distribution of the phosphoric ester *XP* is more or less in accord with the Gram classification, those organisms which contain *XP* being Gram-positive and those which do not being Gram-negative. Two values are shown for the Gram-variable[22] *Neisseria*; one, obtained from a young growth, stained fairly Gram-positive and contained much *XP*, but the other, from an older growth, stained completely Gram-negative and contained no *XP*. It is interesting to note also that the Gram-positive *Neisseria* culture contained considerably less ribonucleic acid than the Gram-negative one. The growth of *Clostridium sporogenes* had passed into the stationary phase before harvesting and stained Gram-negative; but *Clostridium welchii*, which like *sporogenes* contained no *XP*, was definitely Gram-positive when harvested and appears to be an exception to the parallelism of *XP* content and Gram staining.

Organism	Gm. stain	Ribonucleic acid as μ moles purine–pyrimidine per gm. (600 500 400 300 200 100)	*XP* μ moles per gm. (100 200 300 400)	*R*/*D*	*P.S.*
		Purine-pyrimidine / Phosphorus			
Escherichia coli (MS)	−				−
Escherichia coli (H)	−			3·4	−
Proteus vulgaris 882	−			4·4	−
Aerobacter aerogenes A.	−				−
Clostridium sporogenes	−			7·1	+
Cl. welchii NCTC 6784	+			5·4	+
Mycobact. phlei (Sohn)	+			5·0	−
S. fæcalis (Dunn)	+			3·6	±
Yeast (bakers')	+			11·0	
L. casei helveticus	+			4·0	±
S. fæcalis (ST.)	+			3·7	±
Micrococcus	+			8·1	+
M. pyogenes aureus (D.)	+			6·0	+
B. subtilis (from Hay)	+			3·4	++
C. xerosis NCTC 7247	+			3·4	++
Neisseria catarrhalis NCTC 3622	+	YOUNG		3·3	++
	−	OLD		5·9	++

R/*D* stands for the ratio of ribo- to desoxyribonucleic acid, and *P.S.* for penicillin sensitivity: growth inhibition range shown by − = > 10, ± = 10 to 1, + = 1 to 0·1, ++ = 0·1 to 0·01 I.U./ml.

It was observed by Churchman[23] in some classical studies on the sensitivity of more than a hundred bacterial species to the growth-inhibitory action of Gentian Violet (Crystal Violet and lower homologues) that there was a 90 per cent correlation between sensitivity of growth to the dye and staining with it by the Gram technique. The *Neisseria* and *Cl. welchii* and *Cl. sporogenes* were among the main exceptions. There is consequently a complete correlation between sensitivity to Gentian Violet and the presence of the phosphoric ester *XP* in the small group of organisms which we have studied.

The good correlation between the penicillin sensitivity and *XP* content shown by the data of the table led to a study of the natural variation of the *XP* content of a culture of *Mic. pyogenes* var. *aureus* during growth and the effect of penicillin on the course of the variation. In the normal culture, the *XP* content expressed as micromoles of phosphate per gram dry weight was about 300 at the beginning of growth, fell to about 150 during the logarithmic phase and rose again to a resting value of about 300 in the stationary phase. The addition of 1 μgm./ml. (50 μgm./mgm. cell dry weight) of penicillin G to the culture in the late log phase caused the total amount of the phosphoric ester *XP* in the culture to decrease almost linearly to about one-half in the space of one mean generation-time, although during this period slow growth of the culture continued. When growth ceased, the *XP* content of the cells had fallen to less than 50 micromoles of phosphate per gram.

The only biochemical change which has been reported to be initiated immediately after the initial attachment of penicillin to growing cells is the increase in the free nucleotide content[24]. It is evident that the *XP* content begins to decrease also promptly after the initial attachment of penicillin. The synthesis of *XP* is prevented; but its utilization and breakdown is not prevented by the action of the penicillin.

Experiments with disintegrated cells have shown that the phosphoric ester *XP* is attached to the cell envelopes. The presence of this ester in the cell envelopes suggests that the inhibition of its production by penicillin may be connected with the disturbance of cell wall expansion in penicillin-treated cells[25] and with the impairment of function of the osmotic barrier[26] and of the transfer systems located therein[27].

We have been able to confirm the observations of Gutstein[12] and Schumacher[6] that certain micro-organisms do not become Gram-negative after most of the nucleic acid (more than 90 per cent of the ribonucleic acid) is extracted. But it was found that the Gram staining of the cells afterwards diminished as the *XP* was removed by prolonged extraction. In the same way, the intensity of the Gram staining of cells growing in the presence of penicillin has been found to follow their *XP* content. We are consequently inclined to accept Gutstein's view of the arrangement of the components of the cortical layer of Gram-positive bacteria and to consider that the phosphoric ester *XP* represents part of the acidic cortical component which he described[12].

In our experience there is no correlation between ribonucleic acid content and Gram staining; but such a correlation might erroneously be observed if *XP* phosphorus were mistaken for ribonucleic acid phosphorus. We consequently find it difficult to accept the view[10] that the essential component of the so-called Gram complex is magnesium ribonucleate. It seems, however, that there is a strong correlation between the Gram-staining reaction and the presence of the acidic component *XP*. This makes possible the chemical recognition of Gram-positive organisms on a quantitative scale. The correlation of the *XP* content and the capacity of organisms for retaining Gram's stain involves also a correlation with the other characteristics of Gram-positive organisms, their susceptibility to lytic agents, their autolysis and enzymic degradation, their capacity for accumulating amino-acids, the physiological effects of Crystal Violet, penicillin and other substances selectively active upon this group.

It is hoped that the work now in progress in our laboratory on the origin and nature of the *XP* fragment and the relationship of it to physiological function will throw light on its physico-chemical relationship to the known characteristics of Gram-positive organisms.

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[1] Gram, H. C. J., *Fortschr. Med.*, **2**, 185 (1884).
[2] Pelet, G. C., *Chem. Zent.*, 1259 (1907, I).
[3] Benians, T. H. C., *J. Path and Bact.*, **23**, 401 (1919–20). Burke, V., and Barnes, M. W., *J. Bact.*, **18**, 69 (1929). Kemp, H. A., *Stain Tech.*, **6**, 53 (1931).
[4] Schumacher, J., *Z. Bakt.*, Abt. I Orig., 98, 104 (1926).
[5] Deussen, E., *Z. Hyg. InfektKr.*, **85**, 234 (1918); **93**, 512 (1921).
[6] Schumacher, J., *Z. Bakt.*, Abt. I Orig., 109, 181 (1928).
[7] Dreyer, G., Scott, S. G., and Walker, E. W. A., *J. Path and Bact.*, **15**, 134 (1911).
[8] Stearn, E. W., and Stearn, A. E., *J. Bact.*, **9**, 463 and 479 (1924); **10**, 13 (1925); *Protoplasma*, **12**, 435 (1931).
[9] Dubos, R. J., *J. Exp. Med.*, **65**, 873 (1937). Thompson, R. H. S., and Dubos, R. J., *J. Biol. Chem.*, **125**, 65 (1938).
[10] Henry, H., and Stacey, M., *Nature*, **151**, 671 (1943). Henry, H., Stacey, M., and Teece, E. G., *Nature*, **156**, 720 (1945). Henry, H., and Stacey, M., *Proc. Roy. Soc.*, B, **133**, 391 (1946).
[11] Stearn, A. E., *J. Bact.*, **19**, 133 (1930).
[12] Gutstein, M., *Z. Bakt.*, Abt. I Orig., 95, 1 (1925).
[13] Kantorowicz, A., *Münch. med. Wchschr.*, **56**, 897 (1909).
[14] Kruse, *Munch. med. Wchschr.*, **57**, 685 (1910).
[15] Smith, H. W., *Amer. J. Hyg.*, **3**, 607 (1922).
[16] Bartholomew, J. W., and Umbreit, W. W., *J. Bact.*, **47**, 415 (1944); **48**, 567 (1944).
[17] Jobling, J. W., and Petersen, W., *J. Exp. Med.*, **20**, 456 (1914).
[18] Stacey, M., Symposia of Soc. Exp. Biol., **1**, 86 (1947), see p. 99.
[19] Webb, M., *J. Gen. Microbiol.*, **2**, 260 (1948).
[20] Schmidt, G., and Thannhauser, S. J., *J. Biol. Chem.*, **161**, 83 (1945). Stephenson, M., and Moyle, J. M., *Biochem. J.*, **45**, vii (1949).
[21] Mitchell, P., *J. Gen. Microbiol.* (in the press).
[22] Verhoff, F. H., *J. Amer. Med. Assoc.*, **115**, 1545 (1946).
[23] Churchman, J. W., *J. Exp. Med.*, **16**, 221 (1912).
[24] Mitchell, P., *Nature*, **164**, 259 (1949).
[25] Gardner, A. D., *Nature*, **146**, 837 (1940).
[26] Mitchell, P., Symposium of Soc. Gen. Microbiol. on the Nature of the Bacterial Surface, 55 (1949).
[27] Gale, E. F., and Taylor, E. S., *J. Gen. Microbiol.*, **1**, 314 (1947).

LONG ASHTON RESEARCH STATION

A 'FIELD day' was held at the Long Ashton Research Station on July 11, on the occasion of the annual meeting of members of the National Fruit and Cider Institute. Visitors were conducted around the plantations, where they saw field trials, including particularly those dealing with the manuring of blackcurrants and strawberries, mineral deficiencies of apples and potatoes, and systems of culture and management of apples and pears; machinery for pest and disease control, designed at Long Ashton, was demonstrated. In the Cider House an exhibit of fruit, photographs and charts provided information about the varieties of cider apples recommended for

planting, while another section dealt with the manufacture of apple juice.

In the laboratories were various exhibits which perhaps appealed more to the research worker, as they showed the work now in progress in the investigation of fundamental problems.

Sand culture. The plant nutrition sand culture section included the demonstration of equipment needed to study micro nutrient deficiencies in crops on a large scale. The automatic apparatus used to purify several tons of sand for this work was exhibited. This is designed to circulate several hundred pounds of sand at one time in contact with mineral acid or other extracting reagents. Steam issuing under pressure from a special jet assembly is used to transport and heat the sand and acid. The steam is generated in a 30 kW. automatic electrode boiler. The equipment is housed in a building with forced ventilation and neutralizing pits for waste acid. Sand treated in the apparatus is practically devoid of available micro nutrients and contains as little as 10^{-6} p.p.m. molybdenum. Several 'Pyrex' glass continuous distillation units and synthetic ion-exchange resins provide an adequate pure water supply.

Experimental work in progress in the sand culture section includes studies on molybdenum nutrition of *Brassicæ* in relation to nitrogen supply; nutrient balance experiments with potato; relation of heavy-metal toxicity to iron nutrition of sugar beet; elucidation of factors in soil acidity and the accumulation of micro nutrients by crop plants. The work on potatoes demonstrated the complexity of nutrient interrelationships; for example, iron, potassium and phosphorus levels are critical factors in the appearance of deficiencies of each of these elements and of calcium; low potassium accentuates iron deficiency and low phosphorus diminishes chlorosis; iron supply modifies the translocation of potassium and the availability of phosphorus.

Rapid chemical tissue tests. In another laboratory rapid chemical tests for the diagnosis of the mineral status of crop plants were demonstrated. In diffusion methods the easily soluble nutrients are extracted from predetermined portions of fresh plant material, using an acetate buffer solution. Tests for potassium, magnesium, calcium, phosphorus, nitrate nitrogen, and manganese at normal and deficiency levels are made on suitable aliquots of the extracts. Toxicity levels of chlorine, manganese and aluminium can also be determined. In maceration methods Waring and N.I.R.D. blenders are used for the extraction of nutrients from fresh plant tissues. A special carbon, 'Darco *G* 60', is used to clarify the tissue extract. The nutrient levels roughly parallel those obtained by the diffusion method, but are at a higher level.

'Pyrex' glass macerators are used to extract the micronutrients, namely, iron, copper, zinc, lead, nickel, cobalt, etc., from fresh plant material, and special chemical methods are used for their detection. The method is in use to study aspects of the effects of heavy metals on iron metabolism in economic crops. The chemical tissue test data are related to manurial treatment, final yields of crops, and ash analysis of the plants. The methods are valuable aids for a quick diagnosis of a mineral disorder in crop plants.

Radioactive phosphorus. Radioactive phosphorus (P^{32}) is being used to 'tag' phosphatic fertilizers in nutrition experiments on fruit trees and in other investigations on the effect of grass cover-crops in orchards. It is also being used to follow the course of systemic insecticides in plants. Up to the present time, much of the work at Long Ashton has been designed to determine the amount of phosphorus-32 which can be used without invalidating experimental results by radiation injury to the plants. The technique employed, including the use of the Geiger counter and other apparatus, was demonstrated.

Aspergillus niger as a test organism for mineral nutrients. Another exhibit showed the method of using *Aspergillus niger* (Mulder's *M* strain) as a test organism to determine magnesium, copper, zinc and molybdenum available in soils to crop plants. If any essential mineral element is omitted from a basal culture solution containing all others at satisfactory levels, the growth of the fungus, as judged by dry weight and sporulation, is markedly reduced. The response to the addition of this element in various amounts is specific and quantitative; thus a growth series can be prepared for any essential element, which is assessed by intensity and colour of spore cover and dry weight of mycelium. Test materials of soils, tissue extracts or ash of plants are placed in basal solutions containing all the mineral elements other than the one to be determined, and the growth of the fungus under these conditions depends on the amount of nutrient it obtains from the material added. The application of this method to soil problems has shown magnesium deficiency in the presence of potassium shortage, copper deficiency in certain alkaline fen soils where cereal crops were affected and in sandy soils where fruit trees showed 'dieback' symptoms, zinc deficiency in a sandy soil where apples and pears suffer from 'little leaf', and molybdenum deficiency in acid soils where *Brassica* crops showed 'whiptail' symptoms.

Plant hormones. Three different methods in use at Long Ashton for the biological estimation of plant-growth substances were demonstrated. (1) A modified form of the *Avena* coleoptile cylinder test in which the growth of coleoptile sections floating on the surface of the test solution is measured. (2) The *Coleus* leaf abscission test. Excised portions of *Coleus* nodes, each with an attached petiolar base, are mounted on damp filter paper. The cut end of the petiole is then covered with a small disk of filter paper impregnated with the test solution, and the time taken for the abscission layer to develop is noted. (3) The tomato ovary test. In this test unpollinated tomato ovaries are treated with known volumes of test solution and the rate of growth of the young fruitlets is measured over a period of six days. The growth is compared with that induced by known amounts of 2-naphthoxyacetic acid.

By means of charts and diagrams, it was shown how these tests are being used to study various pomological problems, in particular the cause and control of fruit-drop in apples and pears, and the winter dormancy of buds of fruit trees.

Systemic insecticides. This exhibit showed the residual toxicity of apple seedlings to *Aphis pomi* produced by application to the soil of *bis*(β-fluoroethoxy)methane, $CH_2(OCH_2CH_2F)_2$, *bis*(dimethylamino)fluorophosphine oxide, $[(CH_3)_2N]_2POF$ and *bis*(dimethylamino)phosphonous anhydride, $[(CH_3)_2N]_2P.O.O.PO[N(CH_3)_2]_2$, at amounts ranging from 500 to 25 p.p.m. of soil. The phytotoxicity of the materials on apple seedlings and their effect on growth was also demonstrated.

Photographs were used to show the residual toxicity of the above materials to *A. pomi* when applied in aqueous solution to the leaves of apple seedlings.

Virus diseases of tree fruits. Little is known of the actual extent of virus diseases of fruit trees in Britain, but virus-like symptoms are commonly seen in orchards; a number of specimens showing leaf symptoms probably caused by virus infection were shown, including mosaics, ring-spots, line-patterns, and necrotic spots. In addition to leaf symptoms, virus infection can cause changes in growth habit; this type of symptom was illustrated by rubbery wood of apple and stunt of plum. In rubbery apple, lignification of the wood is irregular and delayed, with the result that the young branches are flexible and soft and the tree has a 'weeping' habit of growth; in stunted plum the wood in the shoots is very poorly developed, while the tissues outside the wood are thick and spongy, and as a result the shoots are very brittle. In both diseases the internodes are shortened. Neither of these diseases causes leaf symptoms on the host on which they were first recorded, but plum stunt causes a faint mosaic on the cherry root-stock *F*.12/1, an example of which was shown. G. T. SPINKS

ELECTRONIC INSTRUMENTS AND DEVICES

AT first sight, the exhibition of the Institution of Electronics (N.W. Branch), held at Manchester during July 19–21, was perhaps a little disappointing after last year's brilliant display; but a closer inspection revealed that, although there were fewer spectacular demonstrations, a remarkable number of new, ingenious and useful devices were on show. Since it is obviously impossible to mention them all in the space allowed, a few of the most novel and interesting exhibits will be described.

An outstanding feature of the exhibition was the substitution of television demonstrations for the usual film shows. The receivers used were all built by members of the Institution, either from a commercial kit of parts or from government surplus equipment, and a short lantern lecture on the elementary principles of television preceded each demonstration.

Among the high-vacuum equipment displayed by British American Research, Ltd., was a new type of gauge known as the 'Alphatron', which has a linear response from 1 micron to 10 mm. of mercury. It is an ionization gauge in which a small quantity of radium provides a constant source of alpha-particles as the ionizing agent, and is consequently more robust and stable than the conventional type which uses electrons emitted from a heated filament.

Dawe Instruments, Ltd., displayed a stroboscope specially designed for viewing the moving shuttle of a textile loom. It uses an extremely high-intensity flash which gives a clear view of a moving object at very low repetition-rates, and a remote phase-control enables the operator to view the shuttle at any position during its traverse. The same firm also demonstrated its sound-level meter, which has been completely redesigned and now, while retaining the features of the earlier model, has its size and weight reduced by approximately one-half.

A high-voltage insulation tester which gives aural warning of the approach of a breakdown was displayed by the English Electric Co., Ltd. A continuously variable D.C. potential of up to 10 kV. is derived by rectification of the output of an air-cored transformer which is fed by a high-frequency valve oscillator. The A.C. components of the ionization current which precedes breakdown are amplified and fed to a small loudspeaker. The instrument is portable and, since the maximum current obtainable is 0·5 mA., it is completely safe. Among other equipment demonstrated by this firm were a 5-kW. induction heater designed as a general production tool rather than for specialized work, and a stepless controller for $\frac{1}{4}$–$\frac{1}{2}$ h.p. D.C. motors using a magnetic amplifier and metal rectifiers.

Interesting demonstrations of the phenomenon of electron diffraction were provided by Ferranti, Ltd. Cathode ray tubes are used in which a specimen of crystalline material is supported in the beam and the diffraction pattern observed on the screen. This firm also has available a continuously pumped tube in which specimens can be changed at will.

The equipment displayed and demonstrated by Fielden (Electronics), Ltd., was an excellent example of the way in which one or two basic instruments can be made to serve a large number of specialized purposes. In particular, the proximity meter, displayed in its basic form at last year's exhibition, and which depends on the measurement of very small capacity changes, has been made the basis of a bewildering variety of new instruments. Perhaps the most interesting application is in a new type of recorder which has the sensitivity of a high-grade pointer galvanometer but sufficient power to operate a substantial pen. A servo mechanism combined with the proximity device causes the pen to follow the pointer by maintaining a constant capacity between light vanes fixed to each. There is thus no mechanical contact between the meter and the recording mechanism. A similar principle is involved in an instrument for recording changes in level of a liquid as in a manometer or thermometer. Other applications which were illustrated involved counters, tolerance gauges, moisture indicators and a recording hygrometer.

A new standard signal generator by Marconi Instruments, Ltd., provides a continuously variable output from 0·4 micro-volts to 4 volts in the frequency range 15 kc./s.–30 Mc./s. Several unusual features are incorporated: a crystal-controlled oscillator for calibration checking and a novel form of concentric terminating unit are of special interest. The latter provides three output conditions—source impedances of 75 ohms and 30 ohms and a dummy aerial—and the fundamental circuit of each is indicated by a line diagram which changes as the switch is changed.

Metropolitan-Vickers Electrical Co., Ltd., displayed the precision wave-guide test gear for the 3-cm. band which has been developed in conjunction with the Telecommunications Research Establishment of the Ministry of Supply. Its own centimetre-wave signal source, which is of extremely small dimensions, was also on show. The latter provides a signal, tunable between 8,500 and 9,700 Mc./s., from a 723 *A/B* reflex klystron with a built-in wavemeter and attenuator.

The new audio-frequency wave analyser displayed by Muirhead and Co., Ltd., has been produced in collaboration with the Pametrada Research Station, Wallsend. It is designed primarily to assist the investigation of noise and vibration in marine tur-

bines, and operates in the frequency range 19–21,000 cycles. The weight and size of the equipment have been minimized by the use of resistance–capacitance circuits in place of the usual inductance–capacitance type which, at these frequencies, would require very large iron-cored chokes. The analyser has two selective amplifiers in series which may be exactly in tune, 3 per cent apart or 10 per cent apart, to provide three different band-widths.

A number of new valves which, hitherto, have not been manufactured in Great Britain were displayed by Mullard Electronic Products, Ltd. Of special interest were a 3-cm. band reflex klystron with an output of 25 mW., and two new thyratrons, one containing xenon and the other hydrogen. These should prove useful to workers who have been relying on supplies of American surplus equipment.

F. C. Robinson and Partners, Ltd., demonstrated the 'beta' thickness gauge made by the Baldwin Instrument Co., Ltd. A radioactive isotope emits β-rays which fall on an ionization chamber. Any material placed between the two will absorb part of the radiation, and the change in ionization can be related to the thickness of the sheet. The instrument is normally calibrated to read mass per unit area; but if a material of constant density is used it can be made to read thickness directly. Also on view at this stand was the Scophony–Baird home tape recorder, which gives remarkably high-quality recordings lasting half an hour on a 1,200-ft. reel of plastic tape impregnated with iron dust.

In conclusion, perhaps a word of congratulation to the exhibitors in general might be allowed on the extremely attractive, though modest, appearance of all the displays.

C. A. TAYLOR

BRITISH ELECTRICAL AND ALLIED INDUSTRIES RESEARCH ASSOCIATION

ANNUAL REPORT FOR 1948–49

THE work of the British Electrical and Allied Industries Research Association for the year ended September 30, 1949, is reviewed in the twenty-ninth annual report, issued recently*.

The Association has long played a part in the scientific and technical development of the electricity supply industry, and this has been recognized by the British Electricity Authority by the adherence as ordinary members of the Association of the Central Authority and of the Area Boards. In reviewing the general structure of the Association, which is based on twenty-three sectional committees, stress is laid on the useful scientific liaison which the Association effects. These committees, which have a primary responsibility for advising on research policy in their respective fields, form a meeting ground for research workers from industry, government establishments and from the universities, and their influence is, in consequence, a good deal wider than might be inferred from their immediate responsibilities to the Association. It is pointed out that, as the Association serves an industry which has within the organisations of its members very great technical resources, it is natural that the Association itself should tend to pursue "longer term, more fundamental and background research".

The subject of electrical engineering materials stands very high in the list of the Association's activities. Important fundamental work on dielectrics has been carried on both in the Association's laboratories and on an 'extra-mural' basis in several university departments and at the National Physical Laboratory. Research on magnetic materials, directed towards the improvement of the quality of electrical sheet-steels and to the production of improved permanent-magnet materials, has, for the most part, been supported in university laboratories. Electrical discharge phenomena have been the subject of extensive research both in relation to problems of direct practical interest in connexion with circuit-breaking and also in the fundamental field. The application of the theory of the electrical discharge, which was developed by Mr. C. E. R. Bruce to certain astrophysical problems, has been further extended by him.

Among the numerous researches on very varied topics listed in the report may be mentioned: the use of wind-power for generation, further work on communication interference and radio interference, short-circuit stresses in transformers and parasitic forces in integrating electricity meters. A total of ninety reports was issued during the year. In a paragraph dealing with organisation and staff, an interesting comment is made on the incidental function which the Association performs in training young scientific staff for the electrical industry.

* British Electrical and Allied Industries Research Association. Twenty-ninth Annual Report, October 1, 1948, to September 30, 1949. Pp. 188. (Leatherhead: British Electrical and Allied Industries Research Association, 1950.)

UNIVERSITIES AND MANAGEMENT

IN the concluding address to the British Institute of Management conference at Harrogate in November 1949, Lord Lindsay stated that we are living in an age of technological revolution and that the productivity of a modern nation depends upon science and perhaps even more so is connected with a spirit of scientific research. By scientific research is meant not just what is taught and produced in the natural science faculties but that taught and produced in any proper university environment. It is a restless inquiring spirit, and the economic success of a modern industrial nation depends upon how far that spirit is pushed right down through the whole of society. To achieve the things Great Britain requires will depend upon two factors, the first being the extent to which this spirit of scientific research goes; it should not be confined to people in the universities but sent right down to the men at the bench. The second is how far each individual has public concern, that is, concern with how the country is run, understanding of the common man and those items needed in the structure of society.

The responsibility of the university in relation to the job would therefore seem to be to produce the science and skill necessary for our modern economic situation—more especially to introduce the scientific spirit, thought and outlook—and to give everybody a sense of citizenship. This means that university training must not be purely specialized although it must have a specialist or technical side. "An arts degree tends to produce an awful lot of uplift and makes people somewhat impractical and out of touch

with ordinary life." What is really required is specialization and general education. At the new university in North Staffordshire (Stoke) it is proposed to start a general course for students who will not know whether they are science or arts students in the first year. They will follow one course and thereby all have a common background of understanding. Since one of the regrettable academic trends in recent years has been the excessive departmentalization in technology and science it is hoped to form a community with a common aim and thought in North Staffordshire in which the professors will form an essential part.

Lord Lindsay then raised the question of what part the universities can play in education for management. He suggested that management needs certain technical information which can be learned in technical colleges, but that the university should only be concerned with providing future managers with a critical faculty and showing them the relevance of their subject studies to matters which are not specialized. The universities should not provide a special course in management and there should not be people in universities studying for a "B. Man" degree living together as potential managers. A student at the university who hopes to go into business management should study something that has a strong sociological side, like Oxford Modern Greats. At the university they should also be given a sociological bent of mind, the ability to see the importance of structure in organisation and groups.

T. H. HAWKINS

CONSTITUTION OF MARS

A PAPER by K. E. Bullen, "On the Constitution of Mars"[1], suggests that the earth and Mars are of the same primitive composition. On the basis of an earth model—referred to in the paper as model *A*—which was advocated by Bullen in "An Introduction to the Theory of Seismology" (1947), W. H. Ramsey assumed that the density variation in the earth's deep interior is essentially determined by pressure rather than by changes in the materials present, and found a discrepancy in fitting the planet Mars to the hypothesis that the terrestrial planets are of the same primitive composition. The discrepancy is considerably less than that found by H. Jeffreys on the hypothesis that the large change in density across the boundary of the earth's central core is due to a change of material rather than to pressure. Ramsey showed that the discrepancy could be removed if model *A* were modified to include an allowance for the gravitation of the heavier elements towards the centre of the earth.

In the present paper, Bullen shows that the discrepancy is fully removed by an earth model *B* instead of *A*, model *B* being constructed on the basis of a compressibility-pressure hypothesis. In this model there is a sharp density increase from 3·36 to 3·37 gm./c.c. at a depth of 80 km., followed by a fairly steady density gradient down to a depth of 2,700 km. After this the gradient increases sharply for the next 200 km., the density being 5·57 gm./c.c. at the base of the mantle. Inside the central core the density ranges from 9·74 to 12 gm./c.c. at a depth of 4,980 km., and then rises sharply, reaching a value of 17–18 gm./c.c. at the centre. This model is independent of the observations of the radius and mass of Mars and Venus, so that no *ad hoc* adjustments are involved in fitting it to the planets. In fitting Mars to the hypothesis of the same primitive composition for the terrestrial planets, the most satisfactory agreement is obtained on the assumption that Mars has an inner core in the same proportion by mass as the earth.

The calculations show that the results are consistent with a large proportion of nickel–iron in the inner cores of the planets, and some higher-density additional material. The subject is also discussed by Bullen and Ramsey[2].

[1] Bullen, K. E., *Mon. Not. Roy. Astro. Soc.*, **109**, 6 (1949).
[2] Bullen, K. E., and Ramsey, W. H., *Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, **6**, 1 (1950).

AIR HYGIENE AND AIRBORNE INFECTION

A SPECIAL report of the Medical Research Council, entitled "Studies in Air Hygiene"*, is a symposium written chiefly by a group of workers led by Dr. R. B. Bourdillon, who continued the work on problems of airborne infection and air disinfection begun under the direction of the late Sir Patrick Laidlaw and continued under Dr. C. H. Andrewes. It states in the preface that this publication must be accepted as a landmark in the study of air hygiene. Not only have various practical methods of air disinfection been discussed and compared, but also a reliable and easy technique for the quantitative estimation of bacterial contamination of the air has been found.

The work described in the report falls into four sections: first, there are detailed accounts of instruments developed for sampling air and experimental and theoretical examinations of factors which influence the efficiency of these instruments; second, the report discusses practical methods of air-disinfection, special attention being directed to the value of the aliphatic alpha-hydroxy-carboxylic acids; third, field studies of the levels of bacterial contamination of the air in theatres, homes, factories, etc., are described; and fourth, the report discusses a few animal experiments on the transmission of airborne infections. A critical evaluation of the different methods of air disinfection ends the report, of which the appendixes and five pages of references to the literature enhance its value.

Field trials now in progress will help to decide whether improved air hygiene will result in improved health. At present, the preface to the report warns us, we must not assume that unselective reduction of the number of bacteria in the air of buildings will necessarily reduce the number of overt infections of people living in them. On the other hand, Dr. L. Colebrook and his colleagues at the Birmingham Accident Hospital have shown that secondary infection of burns can be largely eliminated by strict aseptic technique carried out in a room ventilated by an abundant stream of filtered air; effective methods of laying blanket-dust have reduced cross-infection in fever and surgical wards; and appropriate methods of air hygiene have protected industrial workers from dangerous bacteria.

* Medical Research Council. Special Report Series No. 262: Studies in Air Hygiene. By R. B. Bourdillon, O. M. Lidwell and J. E. Lovelock; with W. C. Cawston, L. Colebrook, F. P. Ellis, M. van den Ende, R. E. Glover, A. M. Macfarlan, A. A. Miles, W. F. Raymond, E. Schuster and J. C. Thomas. Pp. iv+356+33 plates. (London: H.M. Stationery Office, 1948.) 7*s.* 6*d.* net.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Trifluoromethyl Derivatives of Phosphorus, Arsenic and Sulphur

THE synthesis of iodotrifluoromethane and iodopentafluoroethane[1] has opened up a route to the synthesis of organo-metallic compounds containing perfluoroalkyl groups. The mercurials CF_3HgI and CF_3CF_2HgI have been prepared by the reaction of the fluoroiodides with mercury in the absence of a solvent[2], and these may readily be converted into the corresponding dimercurials (for example, $Hg(CF_3)_2$)[3]. The reactions of iodotrifluoromethane with phosphorus, arsenic and sulphur have now been investigated and are found to yield organometallic compounds.

The interaction of yellow phosphorus and iodotrifluoromethane in sealed tubes at 220° is almost complete and leads to the formation of a mixture of $P(CF_3)_3$, $P(CF_3)_2I$ and $P(CF_3)I_2$. These compounds have been fully characterized and have boiling points 17·3°/760 mm., 73°/755 mm. and 133°/413 mm. respectively. Phosphorus *tris* trifluoromethyl burns in air, and, like the iodo compounds, is quantitatively hydrolysed to fluoroform by dilute alkali; this constitutes a convenient method of analysis.

The combination of arsenic with iodotrifluoromethane takes place smoothly at 220°, and similarly yields $As(CF_3)_3$ (b.p. 33·3°); $As(CF_3)_2I$ (b.p. 14°/54 mm.) and probably $As(CF_3)I_2$. These compounds are also readily hydrolysed to CF_3H.

The reaction with sulphur occurs at temperatures above 200°. One of the main products is thiocarbonyl fluoride, CSF_2, and in this respect there is a parallel with the reaction between iodotrifluoromethane and oxygen, which leads to the formation of carbonyl fluoride. The amount of thiocarbonyl fluoride present in the product increases with increase in reaction temperature. With a temperature of 205°, other products can be isolated, one of which has the molecular formula $C_2S_2F_6$ (b.p. 34·5°). It probably has the structural formula $CF_3—S—S—CF_3$, and is hydrolysed by alkali without the formation of fluoroform. The compound $CF_3—S—CF_3$ is also believed to be present in the reaction product.

The chemistry of these new organometallic compounds is being investigated in detail, and the study is being extended to include the corresponding pentafluoroethyl derivatives. The reactions of iodotrifluoromethane and iodopentafluoroethane with other non-metals and metals will be described in subsequent communications.

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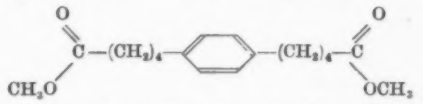
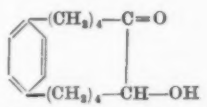
[1] Banks, Emeléus, Haszeldine and Kerrigan, *J. Chem. Soc.*, 2188 (1948).
[2] Emeléus and Haszeldine, *J. Chem. Soc.*, 2948 (1949).
[3] Emeléus and Haszeldine, *J. Chem. Soc.*, 2953 (1949).

Synthesis of a Benzene Ring with a Ten-Membered Para-Bridge

WE have recently investigated the synthesis of para-bridged benzene rings by dehydrogenation of maleic anhydride adducts of large ring dienes[1]. As this method is very laborious, we decided to find the lowest possible number of carbon atoms necessary to form a para-bridge starting from a preformed benzene ring, and then to use our dehydrogenation method systematically only for smaller bridges, which cannot be synthesized by ring closure. We have used the acyloin ring closure as described by Prelog and collaborators[2], and cyclized the diester



prepared according to Ruzicka and collaborators[3] from pure *p*-xylene. Surprisingly, we obtained the acyloin



in 70 per cent yield (b.p. 150–160°, 0·3 mm. mercury). After standing in the icebox, it solidified to a very low-melting crystalline solid (found: C, 78·07; H, 8·93; calculated for $C_{16}H_{22}O_2$: C, 78·01; H, 9·00 per cent). In alcohol with platinum oxide, this compound took up one mole of hydrogen and the corresponding diol was obtained (m.p. 102–103°; found: C, 77·39; H, 9·73 per cent; calculated for $C_{16}H_{24}O_2$: C, 77·37; H, 9·74 per cent). The diol consumed the theoretical amount of periodic acid. The high yield of the pure acyloin is interesting, as under identical conditions the cyclization reaction gives a yield of only 58 per cent *cyclo*tetradecoin. It seems that the shortest para-bridge will have less than ten and more than six carbons, which is the length of the shortest bridge in the meta-position[4].

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[1] *Canad. J. Res.* (in the press).
[2] Prelog, Frenkiel, Kobelt and Barman, *Helv. Chim. Acta*, **30**, 1741 (1947).
[3] Ruzicka, Buijs and Stoll, *Helv. Chim. Acta*, **15**, 1220 (1932).
[4] Prelog, Wiesner, Ingold and Hafliger, *Helv. Chim. Acta*, **31**, 1325 (1948).

Quantitative Paper Chromatography on Mixed Solutions of Nickel and Cobalt, and Determination of both Elements

THE chromatographic procedure used in this work is as follows: Whatman paper No. 1 cut into 25 cm. × 1 cm. strips. Solutions to be determined (50 per cent by vol. hydrochloric acid) are taken from automatic horizontal burettes[1]. The solutions contain the desired amount (γ) of each cation in 0·01 ml. This volume of solution is deposited on the paper strip at 3·5 cm. distance from its top, and the drop is rapidly dried at 35–40° C.

This is to ensure the smallest possible salt spots. The strips carrying the salt spots and others containing hydrochloric acid (50 per cent) (0·01 ml.) are developed in parallel in a presaturated closed vessel. Presaturation is reached by leaving cotton wool soaked in the solvent chosen in the vessel overnight. The platform from which the paper strips will hang (downward development) is also provided with soaked cotton wool. The experiments are carried out in a room the temperature of which is controlled by thermostat (20° C.), on wooden tables.

The solvent chosen for developing cobalt separately from nickel has an acetone basis. It has been shown that 1·4 per cent alcohol and 1 per cent dry hydrochloric acid in acetone gives the best separation. We have succeeded with solvents containing less hydrochloric acid (up to 0·6 per cent by titration); but not more than 1·4 per cent alcohol[2]. First the alcohol is saturated with dry hydrochloric acid in ice and prepared freshly each week. This solution is kept on ice in a tightly corked bottle. The ternary solvent is prepared from this one, by adding acetone. It is freshly prepared each time the chromatographic vessel has to be newly saturated, which happens every two or three days.

This ternary solvent was used in the following experiments; but it seems that if ethyl alcohol is replaced by amylic alcohol and benzene is added, aqueous concentrated hydrochloric acid can be used instead of the gaseous acid. Such solvents have only been used qualitatively; they move very slowly in the paper, so that development takes much longer (4–5 hr.).

The acetone-base solvent is much quicker, and the front reaches 20 cm. from the deposit mark after 60–90 min. With this solvent, nickel remains where it was deposited, whereas cobalt travels along with the front.

When the development is considered to be sufficient, the strips are rapidly dried at 35–40° C. and cut up in the following manner for elution: nickel is on the upper half strip, measuring 10·2 cm. from the top; cobalt is on the bottom half. This strip is cut 1 cm. below the line of the front and 10·2 cm. measured off. Each strip is cut arrow-shaped at the bottom according to Martin's method.

Elution takes 2 hr. with hydrochloric acid (50 per cent by vol.). Eluted nickel is run directly in a 10-ml. calibrated flask, whereas cobalt is run in a small conical flask. Before taking the eluted strips away, both sides are rinsed with a few drops of 50 per cent hydrochloric acid. In both cases, the determinations have to be carried out in the absence of free hydrochloric acid. Therefore, the flasks receiving eluates are weighed, before and after elution, so as to know, as exactly as possible, how much acid has been used, and thus how much ammonium hydroxide is necessary to neutralize it.

Solutions to be determined are brought to 10 ml. with redistilled water after adding the following reagents[3]:

For nickel:	after neutralization of the 3-ml. hydrochloric acid (1 : 1)	
	Spekker acid	0·1 ml.
	Ammonium citrate	1·00 ml.
	Iodine solution (0·1 *N.*)	0·25 ml.
	Dimethylglyoxine (0·001 *N.*)	2·00 ml. replaced in the blank by 2·00 ml. of (1 : 1) ammonium hydroxide
For cobalt:	after neutralization of the 3-ml. hydrochloric acid (1 : 1)	
	Spekker acid	0·20 ml.
	Sodium acetate, 50%	1·00 ml.
	Nitroso-*R*-salt	0·50 ml. (absent in blank)
	Nitric acid (d = 1·42)	0·50 ml.

Both elements are determined using the Spekker absorptiometer, water setting 1, cells = 1 cm., filter No. 602, and reference curves for nickel from 0 to 25 γ; for cobalt from 0 to 20 γ.

DETERMINATIONS OF BOTH ELEMENTS IN 0·01 ML. OF THE MIXED SOLUTIONS

Amounts in the mixture		Recovered		Means	
Cobalt (γ)	Nickel (γ)	Cobalt (γ)	Nickel (γ)	Cobalt (γ)	Nickel (γ)
10	10	10·08/10·24 10·16/10·00 10·18/10·10 10·08/10·24 10·08/10·40 10·37/10·16 10·32/10·16 10·16/10·02/ 9·96/	10·37/10·25 10·25/10·25 10·06/10·50 9·75/ 9·50 10·47/10·46 10·06/10·00 10·06/10·25 10·75/ 9·37	10·17 (+0·23– 0·21)	10·14 (+0·36– 0·77)
2	10	1·80/ 1·90 2·05	9·99/ 9·75 9·87	1·91	9·87
5	10	4·60/ 4·80 5·15	9·87/ 9·63	4·85	9·75
20	5	19·60/18·80/ 20·00	6·00/ 5·18/ 5·18	19·70	5·45

The procedure can thus be considered quantitative with the synthetic mixtures studied. Further investigations are necessary, using alloys. The limits of the respective proportions of both cations must also be studied. We propose to examine this procedure on a bigger scale, using paper pulp columns.

We thank the Institut pour l'Encouragement de la Recherche Scientifique à l'Industrie et à l'Agriculture (Belgium), and also the Fonds National de Recherches Scientifiques (Belgium) for financial help in carrying out this investigation.

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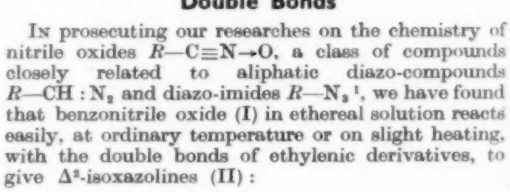
April 6.

[1] *Mikrochemie*, **33**, 2/3, 217 (1947).
[2] *Mikrochemie*, **34**, (2), 219 (1949).
[3] Haywood, "Metallurgical Analysis".

A New Reaction of Ethylenic Double Bonds

IN prosecuting our researches on the chemistry of nitrile oxides $R—C{\equiv}N{\rightarrow}O$, a class of compounds closely related to aliphatic diazo-compounds $R—CH:N_2$ and diazo-imides $R—N_3$[1], we have found that benzonitrile oxide (I) in ethereal solution reacts easily, at ordinary temperature or on slight heating, with the double bonds of ethylenic derivatives, to give Δ^2-isoxazolines (II):



exactly in the same way that aliphatic diazo-compounds and diazo-imides combine with ethylenic derivatives yielding respectively pyrazolines and dihydro-triazoles.

The following olefinic compounds have been tested by us with positive results: allyl alcohol, chloride,

bromide, iodide, allyl ether and allyl sulphide; vinyl acetate, chloride and cyanide; methyl acrylate, methacrylate, maleate, fumarate, citraconate and mesaconate; maleic and citraconic anhydrides; styrene, ω-bromo-styrene, stilbene, benzylideneacetone, indene, bicyclopentadiene. The yields are generally good. Allyl ether and allyl sulphide react with two molecules of benzonitrile oxide. With methyl maleate and fumarate, methyl citraconate and mesaconate, two different phenylisoxazolinedicarboxylic acid dimethyl esters have been obtained, probably the *cis* and *trans* isomers which are theoretically possible for isoxazoline derivatives of type (II).

Since an ethereal solution of benzonitrile oxide is readily prepared from benzhydroximic chloride, $C_6H_5C(:NOH)Cl$ (in ether), and aqueous sodium hydroxide, and as the isoxazoline derivatives obtained are solids easily crystallizable and with definite melting points, the reaction can be of value for the identification of unsaturated liquid substances, and gives a new way for studying the reactivity of different types of double bonds.

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[1] Quilico, A., and Speroni, G., *Gazz. Chim. It.*, **76**, 148 (1946). Stagno d'Alcontres, A. Q., and Stagno d'Alcontres, G., *ibid.*, **80**, 140 (1950).

Structure of *cyclo*-Octatetraene

A communication[1] on the above topic has just come to our attention, in which the authors have reasoned from some frequency calculations to the conclusion that *cyclo*-octatetraene probably has the D_{4d} structure, with the D_4 structure a less likely possibility. It is the purpose of the present note to point out that the vibrational spectra[2] of the deuterium derivative of *cyclo*-octatetraene, published some time ago, enable the method of reasoning as well as the D_{4d} conclusion to be refuted.

The frequency calculations[1] are based on the D_{4d} model, which has high symmetry and thus lightens the numerical burden. On the basis of an assumed set of force constants, the twenty-six distinct frequencies were calculated and compared with the observed spectra. The agreement between calculated and observed values was then taken to indicate that the assumed structure was correct. Among others, there are the following difficulties with this argument. The calculation places a total of seven C—H bending frequencies in the region 1,550–1,750 cm.$^{-1}$, of which all but one are identified with observed frequencies in the range 1,442–1,734 cm.$^{-1}$. If this identification is correct, the frequencies would be calculated to shift in the deuterium analogue by about a factor 0·7–0·8. In practice, the shifts are very much smaller than this for *all* the principal observed frequencies in the range 1,442–1,734, the largest being about 10 per cent, and most changing by only 2–5 per cent. Thus the agreement between calculation and experiment would be badly spoiled in the deuterium compound, which presumably has the same structure and force constants.

The authors also state that "the very strong infra-red frequency at 675 has to be explained as a combination". This band is indeed very strong, being the most intense in the rock-salt region. It is therefore doubtful whether it should be assigned to a combination-tone. The difficulty is the more acute because at 629 there is a second, even stronger band, of which Saksena and Narain[1] were apparently unaware. Actually, we believe this pair of bands is a resonance doublet arising from interaction between an extremely intense fundamental and a combination tone. The analogous band in the deuterium compound is single[2].

The most serious objection to the D_{4d} structure is not mentioned by Saksena and Narain, although it has been pointed out several times[2,3,4]. The selection rules for this structure forbid the appearance of a given vibration in both infra-red and Raman spectra. There are observed about a dozen coincidences, all told, between the principal infra-red and Raman frequencies in *cyclo*-octatetraene, and one or two less in the deuterium analogue. These might, of course, be called 'accidental' or the result of violation of selection rules. It seems more straightforward to assume that the D_{4d} structure is not correct and to consider instead structures that require a limited number of coincidences, such as D_4 (10 coincidences) or D_{2d} (15). We believe the D_4 structure to be the actual one.

We have recently issued two reports[5,6] of our work on the structure of *cyclo*-octatetraene under the auspices of the U.S. Navy's Office of Naval Research. The subject-matter of these reports will be submitted in the immediate future for publication in the *Journal of the American Chemical Society*.

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[1] Saksena and Narain, *Nature*, **165**, 723 (1950).
[2] Lippincott, Lord and McDonald, *J. Chem. Phys.*, **16**, 548 (1948).
[3] Flett, Cave, Vago and Thompson, *Nature*, **159**, 739 (1947).
[4] Lord, *J. Chim. Phys.*, **45**, 47 (1948).
[5] Lippincott, Lord and McDonald, "Vibrational Spectra and Structure of Cyclooctatetraene", Tech. Rep. No. 1, Spectroscopy Laboratory, Massachusetts Institute of Technology.
[6] Lippincott and Lord, "The Thermodynamic Functions of Cyclooctatetraene", Tech. Rep. No. 2, Spectroscopy Laboratory, Massachusetts Institute of Technology.

'Heterochromatin'

The purpose of this letter is to suggest that the use of the word 'heterochromatin' in cytological and genetical literature is undesirable. The word was introduced by Heitz[1,2] to indicate those *Chromosomenstücke* and whole chromosomes that do not undergo telophase transformation and therefore remain condensed throughout interphase and prophase. The later work on this subject, particularly that showing the differential reaction of the heterochromatic parts of chromosomes to culture at low temperature[3–5], has been of great interest and importance, and we want to criticize the name only and not the associated subject-matter.

The ending in '-in' suggests strongly that the name applies to a single chemical substance or to a group

of closely allied substances (for example, adrenalin, mucin, chitin). Our objection is twofold. First, it may be argued that the time has gone past when it was desirable to give to organic compounds names standing outside the accepted system of chemical nomenclature. Secondly, there is no evidence that what is called heterochromatin consists of a single substance or group of closely related substances having distinctive chemical characters. All that can be said with confidence about it from the chemical point of view is that deoxypentose nucleic acid and protein are present; but then these substances are constituents of chromosomes in general. A precise characterization in chemical terms is not yet possible.

The idea behind the word is actually morphological or spatial: it refers to a *region* of a chromosome or to a whole chromosome, not to a particular substance. The use of a word with a chemical connotation to describe a chromosome or a part of it is like giving a chemical name to a mitochondrion: if one were to speak of 'mitochondrin', one would be camouflaging the existence of a heterogeneous system.

The use of the adjective 'heterochromatic' is perfectly justifiable, since it suggests neither chemical homogeneity nor identity of chemical composition in all cells. The word is preferable to 'inert'—a misnomer already pointed out by Schultz[9] in 1936.

The word 'chromatin' is subject to nearly the same criticism as heterochromatin; but it was introduced long ago, at a time when the invention of such words may have been helpful. It is commonly used nowadays in the sense of a substance containing, consisting of, or showing the staining and other reactions of deoxypentose nucleic acid. In the present state of biochemical and genetical knowledge, it seems doubtful whether it continues to serve a useful purpose.

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[1] Heitz, E., *Jahrb. wiss. Bot.*, **69**, 762 (1928).
[2] Heitz, E., *Z. indukt. Abstamm. u. Vererb.-Lehre*, **70**, 402 (1935).
[3] Darlington, C. D., and La Cour, L., *Ann. Bot., Lond.*, N.S. **2**, 615 (1938).
[4] Darlington, C. D., and La Cour, L., *J. Genet.*, **40**, 185 (1940).
[5] Darlington, C. D., and La Cour, L., *J. Hered.*, **32**, 115 (1941).
[6] Wilson, G. B., and Boothroyd, E. R., *Canad. J. Research*, C., **19**, 400 (1941).
[7] Wilson, G. B., and Boothroyd, E. R., *Canad. J. Research*, C. **22**, 105 (1944).
[8] Callan, G. H., *Proc. Roy. Soc.*, B, **130**, 324 (1942).
[9] Schultz, J., *Proc. Nat. Acad. Sci.*, **22**, 27 (1936).

Induction of Mutation by High-Energy X-Radiation Produced by a 23-MeV. Betatron

WITHIN a wide range of energies (12·4 kV.–2·2 MeV.) X-rays are all about equally efficient in inducing mutation[1]. The frequency of induced mutations is directly proportional to the dose measured in roentgens[1]. It is of interest to determine whether the high-energy X-radiation produced by the betatron has, for equal ionization in tissue, mutagenic efficiency equal to that of lower-energy radiation. We have therefore made a preliminary investigation of mutations induced by X-radiation produced by the betatron operating at 23 MeV. This produces radiations at all quantum energies from 0 to 23 MeV.

It is a common practice to judge the mutagenic efficiency of radiation by the frequency with which recessive sex-linked lethals are induced in the fly *Drosophila melanogaster*, and this method was used in the present investigation. The general procedure was to place irradiated young Canton-*S* wild males with females of apricot-bar, Muller-5 stock. Red-bar daughters from these matings were, in turn, mated to Muller-5 males. If no red-eyed, non-bar sons resulted from such a mating, a sex-linked lethal was suspected. All recorded lethals were confirmed by rearing one further generation of at least fifty flies from red-bar females crossed with Muller-5 males.

Flies to be irradiated were placed in gelatin capsules which were inserted into cavities in a pressed wood phantom. The beam from the betatron traversed at least 3 cm. of phantom before reaching the flies. The betraton was operated to produce a maximum quantum energy of 23 MeV. and the intensity was about 100 r. per min. Dosage intensity was measured with a Victoreen 100-r. condenser chamber placed in the cavity during a preliminary run of the betatron. Dosages recorded have been called 'roentgens'. A single dose of 2,000 r., 5,000 r. or 7,000 r. was administered to each lot of flies.

All the irradiated *X*-chromosomes which were tested for mutations were obtained from sperms which functioned in fertilization within twenty days of the treatment.

As may be observed from the accompanying table summarizing the results, the average percentage mutation per 1,000 r. high-energy X-rays is 1·70. The corresponding figure for ordinary X-rays as given by Lea[1] is 2·89 per cent. This would indicate that the high-energy radiations are only 0·59 as efficient as ordinary X-rays for the production of lethal mutations. This is in essential agreement with Luce, Quastler and Skaggs[2], who obtained a value of $m = 1{\cdot}4 \pm 0{\cdot}3$ when 20-MeV. X-rays were used on sperms.

X-radiation dosage (r.)	Number of *X*-chromosomes tested	Number of lethals observed	Calc. No. of lethals per 1,000 r.	Per cent mutation per 1,000 r. ($m \pm \sigma$)
7,000	120	17	2·43	$2{\cdot}03 \pm 0{\cdot}49$
5,000	272	22	4·40	$1{\cdot}62 \pm 0{\cdot}34$
2,000	451	15	7·50	$1{\cdot}66 \pm 0{\cdot}43$
Totals	843		14·33	$m = 1{\cdot}70 \pm 0{\cdot}45$
Control	396	0		

The standard deviations given in the last column of the table were determined from $\sigma = \frac{m}{\sqrt{\text{number of lethals observed}}}$

The reason for the difference in effectiveness doubtless lies in a difference in the distribution of ionizations in the irradiated material. High-energy electrons have longer tracks and produce sparser ionization on the average than do low-energy electrons. The densely ionized tail-portion of an electron track will constitute a smaller proportion of the total ionization in the case of high-energy electrons. Since for the production of some lethals two or more ionizations in close proximity may be required, we might expect these lethals to be produced with a lower frequency when high-energy X-radiation is used than with low-energy X-radiation.

We acknowledge with pleasure the assistance of Profs. R. N. H. Haslam and L. Katz in making the

betatron available for this work. Thanks are also due to the National Research Council of Canada and to the National Cancer Society for financial assistance.

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[1] Lea, D. E., "Actions of Radiations on Living Cells" (Camb. Univ Press, 1946).
[2] Luce, W. M., Quastler, H., and Skaggs, L. S., *Amer. J. Roent. and Rad. Ther.*, **62**, 555 (1949).

Identification of Transplanted Tissues in Chick Embryos by Marking with Phosphorus-32

THE technique of transplantation in early chick blastoderms developed by Waddington[1,2] has hitherto been handicapped by uncertainties in distinguishing host from graft tissues during analysis of the resulting embryo. In Amphibia this difficulty has been resolved by heteroplastic grafting between differently pigmented species[3,4], or by the use of vital stains which could be fixed in the tissues[5]. Not a little of the superiority of amphibian embryos as experimental material is due to these techniques. Analogous methods have failed to give an adequate solution of the difficulty in chick embryology. Conveniently available species (as used by Waddington and Schmidt[6]) are not sufficiently distinct histologically, and vital staining is not apparently always well localized[7] and its fixation for subsequent examination in paraffin sections, though possible[8], is not reliable.

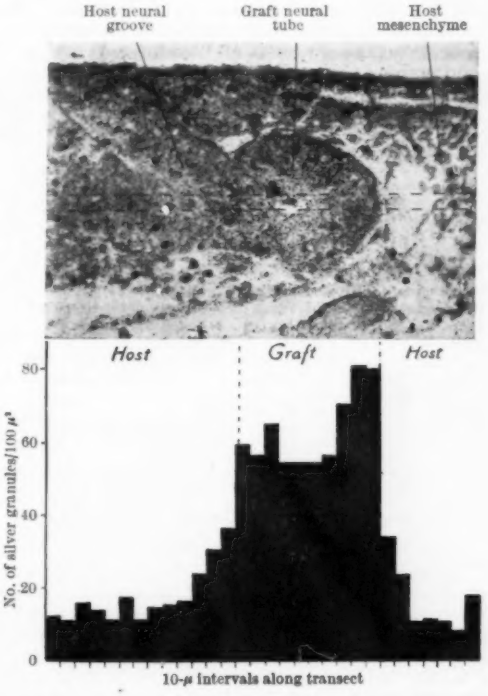
We have found that effective distinction between host and graft tissues of the chick can be obtained by marking one or the other with phosphorus-32, and afterwards preparing an autoradiograph of serial sections of the operated embryo. The technique is as follows.

The injection, 10–15 C. of phosphorus-32 into the albumen of unincubated eggs, is made with sterile precautions into the side of the egg to avoid an initial high concentration immediately over the blastoderm. The injection site is sealed with paraffin wax and the eggs are left for eighteen hours at room temperature with occasional turning. They are then incubated in the usual way for 12–24 hr., according to the stage required for operation. Waddington's transplantation procedure and tissue culture technique are then followed, taking the host embryo from an injected egg and the donor from an untreated egg, or *vice versa*. After cultivation for the usual twenty-four hours, morphologically normal development has occurred in most specimens, though a few are believed to have failed through overdosage. The embryos are fixed in Bouin (2 hr.), dehydrated rapidly and serially sectioned in paraffin. After taking down to water, the slides are covered with autoradiograph stripping film (Kodak, Ltd.) and kept in the dark for fourteen days[9]. They are then developed, stained and mounted. So far, no entirely satisfactory staining technique has been devised; but useful results have been obtained with very dilute Hæmatoxylin followed by Aurantia (a method developed by Mr. J. E. Marner). The intensity of exposure of different regions of the emulsion can readily be estimated by counting the number of silver granules in unit area. Marked and unmarked regions are, however, usually distinct enough for such counting to be unnecessary.

In order to translate with confidence the distribution of silver granules in the emulsion into the distribution of host and graft tissues in the underlying section it is necessary to be satisfied on two points: (*a*) that the radioactive phosphorus which produces the autoradiograph has not diffused to a serious extent from cells originally marked to those originally unmarked; and (*b*) that the scatter of emission of radiation from a radioactive region of the section does not cause a misleading exposure in the emulsion overlying neighbouring non-radioactive regions.

As to (*a*), the only relevant diffusion is of that fraction of the phosphorus which remains in the tissue at the end of the histological process. If diffusion occurred in such a way as to mark cells originally unmarked, or to destroy the marking of cells originally marked, then it would be expected that different extents of positive exposure would occur according to whether the graft was marked or the host was marked in an otherwise similar operation. No such difference has been observed in comparable experiments. Furthermore, closely contiguous tissues, judged on morphological grounds to be host and graft, such as a secondarily induced neural plate in contact with a graft neural plate, are perfectly distinctly marked.

As to (*b*), autoradiographs of embryos grafted in the way described show regions of high and low intensity of exposure which are sharply marked off from each other by narrow zones of rapid transition.



Radioautograph of chick embryo, containing a graft marked with phosphorus-32. The graft has induced a neural groove in the host. Below, histogram showing concentration of silver granules in corresponding positions along the 10-μ wide transect, which is marked by dotted lines on the photograph

In numerous instances the beginning of a zone of transition from high to low intensity coincides accurately with a morphological boundary in the underlying section. If there were a scatter of radiation in such a way as to make the regions of high exposure larger than the regions of radioactive tissue beneath them, then the graft-host boundary must in all these cases lie the precise distance away from the morphological boundary necessary to produce the observed coincidence, which is scarcely credible. This argument is particularly strong in the case of secondarily induced host neural plates where the graft-host boundary can be placed with some confidence at the morphological boundary. It may be concluded that the autoradiograph indicates the borders of graft and host tissue to within about 5 μ. An example, with quantitative analysis, is shown herewith.

There are obviously certain disadvantages to the technique we are describing. There is the difficulty of staining sections, adequately and consistently, through the emulsion. It can perhaps most conveniently be overcome by taking two series, of alternate sections, using a double-bladed microtome, and staining and mounting one series in the usual way, while the other is used for the autoradiograph (a technique due to J. F. Sloane and J. E. Harris, of the University of Bristol). The dispersion of particles around the source makes impracticable very accurate identification, say, of single cells within an intimate mixture of host and graft cells. Finally, the method is rather complex, though not so much so that it cannot be used as a routine. With its aid it should be possible to put past and future experimental results with chick transplantations (and no doubt transplantations in other organisms) on a firmer basis. We should add, however, that so far, in repeating the classical 'organiser' grafts of Waddington[2], we have found nothing to contradict his interpretations, made on morphological grounds; though dispositions of graft and host tissues of lesser importance, which would otherwise have been quite unsuspected, have frequently come to light.

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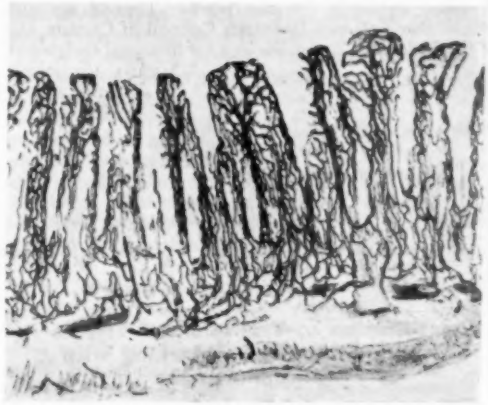
[1] Waddington, C. H., *Nature*, **125**, 924 (1930).
[2] Waddington, C. H., *Phil. Trans. Roy. Soc.*, B, **221**, 179 (1932).
[3] Born, G., *Arch. Entw. Mech. Org.*, **4**, 349 (1896).
[4] Spemann, H., *Arch. Entw. Mech. Org.*, **48**, 533 (1921).
[5] Lehmann, F. E., *Roux Arch. Entw. Mech. Org.*, **117**, 312 (1929).
[6] Waddington, C. H., and Schmidt, G. A., *Roux Arch. Entw. Mech. Org.*, **129**, 522 (1933).
[7] Jacobson, W., *J. Morph.*, **62**, 445 (1938).
[8] Stockenberg, *Roux Arch. Entw. Mech. Org.*, **135**, 408 (1936).
[9] Pele, S. R., *Nature*, **160**, 749 (1947).

A Simple Technique for the Study of Vascular Pattern

Many methods have been evolved for the purpose of demonstrating the microscopical vascular arrangements in tissues, difficulty having been encountered in selecting the ideal injection medium. The excellence of the results obtained by Trueta, Barclay, Daniel, Franklin and Prichard[1] in their investigations of the intra-renal circulation has brought into prominence the use of radio-opaque materials. It is evident from Barclay's account[2] of the methods that the injection procedure is without difficulty and results in good



Longitudinal section of duodenum (42 μ). × 40

filling of vessels with a stable, homogeneous mass, but that the radiological and photographic aspects are more complex.

We have obtained satisfactory results with a considerably modified method which is less time-consuming, more economical and essentially simple. It is based on the conversion of the radio-opaque silver iodide to metallic silver by a photographic developer, and this obviates the radiological technicalities.

Materials. Our trials have been confined to guinea pig tissue, and the apparatus used for the injection process was based on the design used by Trueta and his colleagues[1]. Colloidal silver iodide (10 per cent) is employed as the injection mass, and it flows freely due to low viscosity. Barclay[2] noted that this preparation produced very satisfactory filling of fine vessels; but it had a tendency to become dislodged during the cutting of sections. We, however, have found that it is well retained in the vessels. The fluid is white and the process of injection can be observed in the tissues. In dealing with pale structures where blanching is not very evident, a little Brilliant Green can be added to the injection mass, as it does not adversely affect the colloidal state of the silver iodide. Fixation is effected with formol-acetate (an aqueous solution of 8 per cent formalin and 4 per cent sodium acetate), which also converts the colloidal injection medium into a firm gel. Any routine photographic developer may be used for the transformation of the silver iodide into silver.

Technique. Immediately after killing the animal, the thoracic and abdominal viscera are exposed by a ventral incision, followed by removal of the sternum and the anterior portions of the ribs. The thoracic aorta is freed for a small distance and cannulated. The injection is carried out at systolic blood pressure and naturally in a distal direction. The proximal portion of the thoracic aorta is severed in order to allow the displacement of blood in the cardiovascular system by the injection fluid. During the injection the viscera are kept warm and moist by the application of warm, wet towels. The injection is usually completed in from ten to fifteen minutes. The organs are removed, and portions of about 4 mm. thickness are immersed in the fixative solution for forty-eight hours. On completion of fixation, frozen sections are cut at a trial thickness of 40 μ. The most satisfactory range of thickness can later be assessed according

to the degree of vascularity observed in the trial sections. The frozen sections are treated with the photographic developer until the injected vessels are seen to blacken—a period of about five minutes is satisfactory for *D.*163 (Kodak). After development, the sections are rinsed well in water, dehydrated, cleared and mounted in *D.P.X.* Liberal quantities of the mounting medium are required owing to the thickness of the sections. The vessels are revealed in jet black against a very indefinite outline of the general tissue structure.

For thin organs such as the stomach and intestine of small animals, the method can be applied to the study of the vascular network of the various layers. Portions of the fixed tissue are cleared by the method of Spalteholz[3], after previous development of the silver iodide, and mounted flat on a glass slide. The vascular architecture of the individual layers is observed by variation of depth of focus with the microscope.

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[1] Trueta, J., Barclay, A. E., Daniel, P. M., Franklin, K. J., and Prichard, M. M. L., "Studies of the Renal Circulation" (Oxford: Blackwell Scientific Publications, Ltd., 1947).
[2] Barclay, A. E., *Brit. J. Radiol.*, **20**, 394 (1947).
[3] Spalteholz, K. W., "Über das Durchsichtigmachen von menschlichen und tierischen Präparaten" (Leipzig, 1911).

Cause of the Absorption of Water by Submerged Shoots

Observations made by Dixon and Barlee[1] recently have inspired a discussion as to the possibility of a transpiration into a saturated atmosphere[2,3]. Dixon and Barlee showed that shoots, placed in a supersaturated atmosphere or being submerged, continue to absorb water for several days. Experiments in pure nitrogen and with narcotics indicate the necessity of respiration. According to the authors it is very probable that respiratory processes supply the leaf-cells with energy to secrete water drawn from the vessels into the leaf spaces. Thoday doubts, however, that water taken up in such amounts could all be retained, and suggests the possibility of transpiration into a saturated atmosphere.

Apparently it has been overlooked by the authors mentioned that in 1935 I published a paper[4], by which in my opinion a satisfactory elucidation has been given of the causes of phenomena similar to those communicated by Dixon and Barlee.

Considerable absorption of water for several days by cut shoots, submerged or covered with 'Vaseline', was observed; this was especially pronounced in the dark. In the light the absorption proved to be insignificant or even negative. The course of the absorption paralleled exactly the course of the gas exchange. In accordance with Sen and Blackman[5], who observed an injection of submerged leaves with water, the cause of the movement of sap was attributed to the occurrence of small differences in pressure in the intercellular spaces, resulting from the different solubility of carbon dioxide and oxygen which are exchanged during the respiratory process. It was shown by means of small variations of temperature, alternate bubbling of readily diffusible hydrogen and air that slight differences of pressure from the order of 1–3 mm. of mercury completely suffice to explain the magnitude of the sap-stream observed. No intake of water was observed when the intercellular spaces were impregnated with water.

The exudated water is retained by the leaves. The weight of a leaf increased by 20 per cent, whereas the volume of the leaf remained the same. In accordance with this the amount of air in the intercellular spaces decreased considerably in the dark, whereas in the light it remained almost constant. Considerable amounts of water are absorbed in this way. A submerged shoot with six leaves weighing 6·355 gm., connected with a potometer, increased 1·032 gm. in weight in 86 hr.; 1·014 gm. entered through the cut surface in the same time.

Thus it appears that the continuous movement of sap is a result of respiration. The process proceeds as long as gas exchange is continuing and the intercellular spaces are not completely impregnated with water. Neither active secretion of water by the leaf cells nor transpiration in saturated air play a significant part in this process.

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[1] Dixon, H. H., and Barlee, J. S., *Sci. Proc. Roy. Dublin Soc.*, 22, 211 (1940).
[2] Thoday, D., *Nature*, **164**, 541 (1949).
[3] Wilson, K.; Thoday, D., *Nature*, **164**, 1013 (1949).
[4] Paauw, F. van der, *Rec. trav. bot. néerl.*, **32**, 293 (1935).
[5] Sen, P. K., and Blackman, V. H., *Ann. Bot.*, **47**, 663 (1933).

Hypersensitivity and Tumour Development in Potato Tubers in Response to Infections with *Phytophthora infestans*

F_2 forms of a certain cross between a *W* variety and a common variety of potato, when inoculated with parabiontic strains of blight fungus[1], were found to produce tumours. These tumours develop on the cut surfaces of tubers which had been covered with a zoospore suspension of low concentration. They developed after an incubation period of 4–5 days at about 20° C. It is thought that this mode of reaction is linked with hypersensitivity to the parasite, because such a reaction has not been observed on a hypersensitive[2] (susceptible) genotype.

The hypertrophic growth of the affected tissues is caused by enlargement and multiplication of the cells which surround those cells that have been destroyed

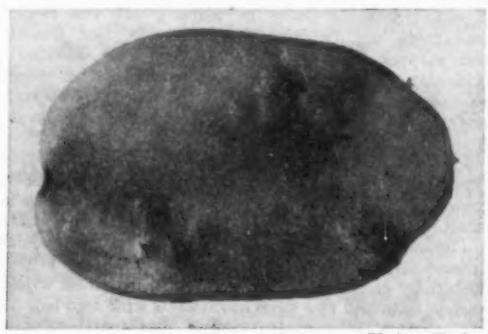

Photo.: *Hughes*

A tuber of an F_2 seedling showing tumours six days after inoculation with a parabiontic strain of *Phytophthora infestans*

by the parasite. These enlarged cells which lose their starch content seem to be identical with normal gall cells. There is no indication of any formation of wound periderm-like tissues. Occasionally the fungus fructifies sparsely on the tumours, a condition never found in normal reacting tissues of hypersensitive genotypes; this is an indication that the tumours so found favour the development of the parasite.

The tubers of the same genotype differ in their capacity to react in the manner described. This variation is connected with physiological differences between the individual tubers of the same plant.

I suggest the following explanation of these phenomena. Besides the gene *R* which controls the degree of sensitivity of the affected tissues to the invading parasite, there is another gene (or genes ?) which enables the cells to grow and divide in response to the influence of substances released by the dying tissues. If, as appears, the 'tumourized' tissues are less sensitive than unchanged tissues, then the parasite has a greater chance of survival and fructification in the former than in the latter tissues.

The most striking feature of these experiments is that a parasite, known only as such because of its tissue-destroying properties, can stimulate certain host genotypes to develop tumours. Moreover, these observations indicate that this capacity of the host to react in such a manner is a stage beyond that of hypersensitivity in the phylogenetical development of the plant types concerned.

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[1] Müller, K. O., and Behr, L., *Nature*, **163**, 498 (1949).
[2] Müller, K. O., *Nature* (in the press).

Sharp Eyespot as a Severe Disease of Oats

Sharp eyespot of wheat[1], caused by *Corticium* (*Rhizoctonia*) *Solani*, is a common disease; but the lesions on leaf sheaths and straws are usually superficial, and there is no evidence that it is of economic importance. Hitherto, it does not appear to have been described on other cereals in Great Britain, though Oört[2] shows a photograph of it on rye in Holland, and Sprague records it on barley[3] and on oats[4] in America. This year a crop of oats has been found in Bedfordshire with many plants severely attacked by a *Rhizoctonia* resembling that obtained from sharp eyespot in wheat. The lesions in oats resemble those in wheat; but the fungus penetrates deeply into the tissues of leaf sheaths and straws, rotting the shoots. The disease is evidently serious; but the loss cannot be estimated because another parasite, the eelworm *Heterodora major*, is attacking the roots and reducing growth of the crop. Many barley and a few wheat plants are scattered among the oats and some show typical superficial sharp eyespot lesions; the vigorous growth of the wheat and barley does not seem to be affected, and contrasts vividly with that of the oats.

The suggestion that sharp eyespot is a more severe disease of oats than it is of wheat or barley is supported by sand culture experiments in which wheat, barley, oats and rye were inoculated with two isolates of *Corticium* (*Rhizoctonia*) *Solani* obtained from sharp eyespot in wheat. Lesions developed on the leaf sheaths of all four cereals, but oats and rye were much more severely affected than wheat and barley; the fungus penetrated more deeply into the shoots of oats and rye and killed about half the inoculated seedlings.

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[1] Glynne and Ritchie, *Nature*, **152**, 161 (1943).
[2] Oört, A. J. P., *Tijdsch. over Plantenziekten*, **42e**, 179 (1936).
[3] Sprague, R., Pop. Bull. 192 Wash. Agri. Exp. Sta. (1948).
[4] Sprague, R. *Phytopath.*, **27**, 798 (1937).

Humidity and Temperature in Grass Microclimates with Reference to Insolation

In view of a recent communication in *Nature*[1] by Miss Champness, it may be of interest to report certain investigations of grassland microclimates resulting from an inquiry into the behaviour of insect larvæ (mostly Tenthredinidæ) during 1947–49.

Shielded wet and dry thermocouples aspirated at a low rate in order to disturb as little as possible any thermal stratification were used in making air temperature and humidity observations in the face of direct insolation. Insect temperatures were taken per rectum, and leaf temperatures by threading thermocouples through leaves. The plots of grasses contained a mixture of species growing wild or semi-wild under conditions of varying density and height.

Curves of air temperature variation within the atmosphere enclosed by the grass have been obtained under suitable conditions of sunshine for vegetation from 25 to 60 cm. in height, thus bridging the gap as regards height between Geiger's[2] cornfields and Miss Champness's grass seedlings. The findings agree in general with their results. Clearly the quality and density of herbage affects temperature and humidity distribution (see also Roussakov[3]) and may compensate for height changes; for whereas in young corn the hottest layer of air is at ground-level and does not become remote from it until growth has proceeded for some time, in growing grass only a few centimetres in height the hottest air layer is already above ground-level. The extent of the cooler, wetter, lower microclimate depends upon the depth of penetration of the sun's rays, which is determined by the angle of these rays (varying diurnally and seasonally) as well as the physical conditions of the vegetation.

This was illustrated at Dundee by records of larval, leaf and air temperatures taken at different levels in vegetation 35–55 cm. in height at different times of the year. Temperatures of freely exposed larvæ and leaves during periods of insolation were 1–3° C. above air temperature. When shielded from radiant heat, leaves were at air temperature while larvæ were at temperatures slightly lower. In July, temperatures above that of air were recorded for larvæ and leaves in the upper half of grass cover, denoting considerable radiant heat penetration. Here a low hot-air zone was recorded. In September and October, plant temperatures fell almost to that of the air and animal temperatures lower, in situations only 5–6 cm. below the grass tips, denoting reduced radiant heat penetration. As expected, a high hot-air zone was noted. Similar results for radiant heat penetration were obtained by exposing differentially connected black-and-white thermocouples *in vacuo* at different levels.

In grass partially flattened due to previous exposure to very strong winds and thereby presenting

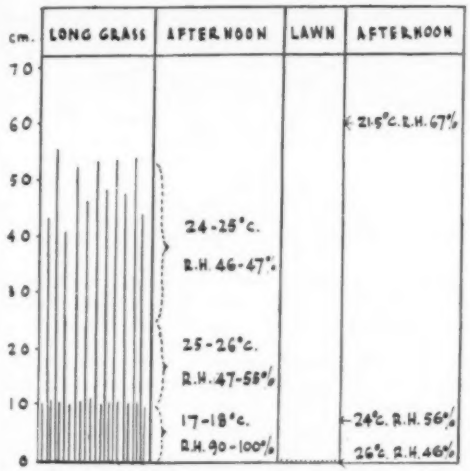

Diagram illustrating air temperature and humidity in relation to density (indicated by the closeness of the vertical lines) and height of grass during a July afternoon of strong sunshine and gentle breeze. The readings are representative of the general conditions existing in an environment varying slightly from point to point

an upper surface of increased density, the high hot-air zone was noted even in July. This observation is comparable to that of Geiger's, in which the appearance of influorescences caused variation in temperature distribution. The possibility must be noted, however, of seasonal variation in the physiological condition of leaves contributing to an alteration of radiant heat penetration[4] and leaf temperature[5].

As regards humidity, observations of the type important to the present argument have been carried out on only one occasion, in 45–55 cm. grass which had been allowed to grow from a lawn condition for three years. Here the added complication entered of an increased density of the lower zone due to the dead grass of previous years. In this case (see chart) the relative humidity roughly follows the temperature gradient, determined primarily by a considerable radiant heat penetration due to a July sun. The hottest layer of air shows a slightly higher relative humidity than the cooler upper air, presumably due to its proximity to the source of moisture in the matted layer. Observations taken during the same afternoon over an adjacent piece of ground which had been retained in its lawn condition showed a reverse relative humidity gradient due presumably to the drying out of the lawn surface.

It may therefore be suggested *à propos* Miss Champness's experiments that, apart from any considerations such as overcrowding, the density of vegetation necessary to retard evaporation sufficiently at low levels to produce a suitable nursery climate will vary not only according to type and height of vegetation, but also seasonally according as the effects of these factors are modified by variation in the angle of the sun's rays. Due to the relative shortness of any seedling herbage, there is the possibility that this factor may be varying significantly in a shorter period of time than the Dundee work in longer grass demonstrates.

A further feature of grass microclimates is the occurrence of temperature inversion during calm, clear nights. Such an inversion was observed at Dundee during the summer of 1947, when the air near the ground in the case of 35-cm. grass was found to be 2–3° C. warmer than above. This state of affairs persisted from dusk until the following morning. Unfortunately, humidity results are not available; however, since the temperatures concerned were around 10–15° C., any drying-out effect would be small.

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[1] *Nature*, **165**, 325 (1950).
[2] Geiger, R., "Handbuch der Klimatologie", **1**, 38 (1930).
[3] Roussakov, R., *Rev. App. Mycology*, **4**, 271 (1925).
[4] Angström, A., *Geografiska Ann.*, **7**, 323 (1925).
[5] Miller, E. C., "Plant Physiology" (McGraw-Hill, 1938).

Principle of an Ion Source for Intense Beams

THE performance of ion sources, associated with accelerating tubes, is limited by space-charge phenomena, particularly troublesome in the vicinity of the extraction aperture. It is therefore desirable to avoid space-charge accumulation along the whole path of the ions. This can be obtained by changing the configuration of the extraction field. The extracting electrode is a short cylinder coaxial with the accelerating tube (a cylinder which replaces the conventional plate with a circular aperture), and the ions pass through a circular slit, machined in this cylinder. The initial velocity of ions is then perpendicular to the axis of the tube, and directed towards it. Let us assume the electric field in the tube to be uniform; then the trajectories are parabolas, all of which cross the axis of the tube at the same point if the beam is homogeneous in energy. For a suitable ratio of the extracting to the total accelerating voltage, this point coincides with the target, at the lower end of the tube. Rough calculations show that the usual orders of magnitude of total and extracting voltages, as well as the length and the diameter of tubes, are quite suitable for this method of extracting and focusing. The ion source must be, of course, either specially designed or suitably modified to fit this mode of extraction[1].

We intend to use a source modified from that of Alfvén's trochotron[2]. In this valve, the electrons follow trochoidal trajectories in crossed electric and magnetic fields. The effective length of the path can be considerably greater than the dimensions of the tube. (The negative 'rail' of the trochotron collects positive ions, when the pressure is not very low. An ion-gauge, based on this principle, has, for a filament emission of 3 m.amp., a sensitivity fifteen times that of the conventional ion gauge with an electronic emission of 20 m.amp.)

Unlike Alfvén, who uses a configuration of electric field favourable to electron concentration (Fig. 1,*a*), we have to apply an electric field focusing the positive ions on to the extracting slit. Such a field defocuses electrons and repels them on to the side walls (Fig. 1,*b*). This repulsion is compensated and the total focusing effect obtained by the use of an inhomogeneous magnetic field which, as is well known, concentrates electrons in its symmetry plane. In the conditions of electric and magnetic fields of Fig. 1,*b*, this focusing effect will exist only for electrons having energies above a certain minimum value. Electrons which have lost energy by collision escape the influence of the magnetic field and are trapped by the side walls. Slowed-down electrons, which no longer

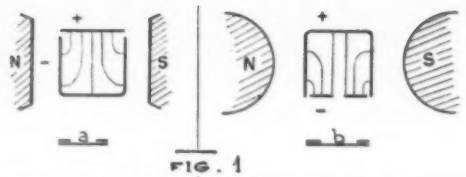

FIG. 1

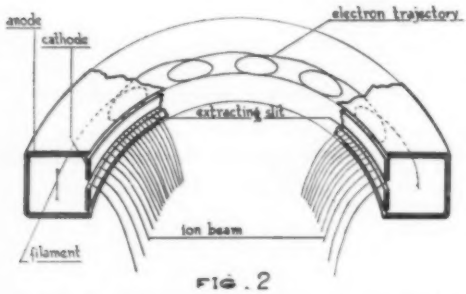

FIG. 2

have ionizing energy, are thus automatically eliminated, whereas, in many types of sources, they are trapped in the plasma, and can only disappear by recombination, diminishing the yield of the source.

Moreover, with a suitable configuration of pole pieces, one can produce magnetic fields which introduce a purely magnetic precession in addition to the precession due to crossed fields. This again increases the length of the path of electrons. In principle, precessions of opposite signs and of nearly the same absolute value should lead to the best result. In practice, one is limited by the instability of the electron beam due to space charge.

Two experimental types have been operated: a linear one for the study of basic properties, and a circular one as a tentative practical embodiment of the type of source described.

The theoretical assumptions were verified and the behaviour with respect to gas consumption and power dissipation found satisfactory. Examination of the adjustment is in progress.

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March 28.

[1] Sommeria, J., in a paper to be published in *Le Journal de Physique et le Radium*, describes the use of a source of the Heil type which he has adapted to annular extraction.

[2] *Nature*, **160**, 614 (1947).

Extraction of the Electron Beam from a 30-MeV. Synchrotron

ELECTRONS of energy up to 20 MeV. have been extracted from the 30-MeV. synchrotron[1] at the Atomic Energy Research Establishment with the aid of a small shunt coil carrying a pulse of current.

The electrons are injected into the synchrotron from inside the equilibrium orbit, and are extracted when the magnetic field has reached its maximum value. The extraction occurs in two stages: the orbit is first expanded by means of pulsed coils above and below the 'donut'; this causes the electrons to spiral outwards until they reach the extractor shunt; the shunt then deflects them tangentially out of the machine.

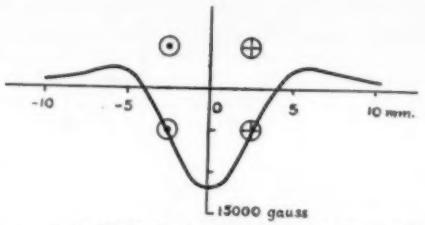

Fig. 1. Vertical field due to square conductor array of side 5 mm. carrying 6,000 amp.

The shunt consists of four conductors of length 6 cm. arranged 5 mm. apart in a square (Fig. 1). These conductors carry a pulsed current of up to 6,000 amp. peak, so timed that the current is a maximum when the electrons enter the shunt. The currents in the conductors produce a vertical field in the plane of the orbit, as shown in Fig. 1. This combines with the guide-field to produce the field shown in Fig. 2; there are two tracks of zero field T_1 and T_2, and it will be seen from the figure that any electrons falling outside T_1 will move over to T_2 and will oscillate about it, being thus carried out of the synchrotron. Unfortunately, the field at T_2 is such as to cause vertical defocusing, so that the shunt must be short; this means that the emerging electrons are still in the fringing field of the magnet, and that consequently the dispersion of the beam is increased.

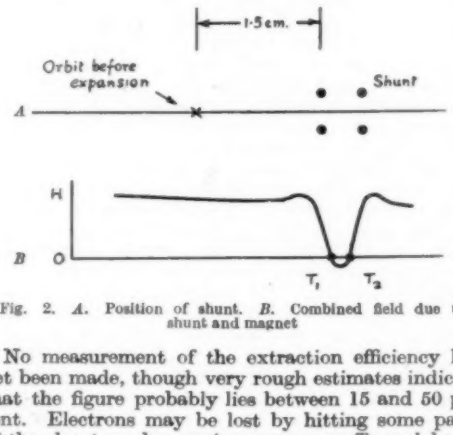

Fig. 2. *A*. Position of shunt. *B*. Combined field due to shunt and magnet

No measurement of the extraction efficiency has yet been made, though very rough estimates indicate that the figure probably lies between 15 and 50 per cent. Electrons may be lost by hitting some parts of the shunt, or by coming very near T_2 and being deflected but not trapped. The proportion of electrons

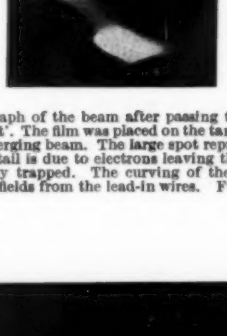

Fig. 3. Photograph of the beam after passing through the glass wall of the 'donut'. The film was placed on the tangential side-arm, at 35° to the emerging beam. The large spot represents the beam, and the curved tail is due to electrons leaving the shunt early or being imperfectly trapped. The curving of the beam is due to stray fields from the lead-in wires. Full size

deflected but not trapped should not be very large, however, since although the mean spiral pitch of the electron is of the order of 0·01 mm., there will be betatron oscillations with amplitude of the order of 1 mm. superposed on this, making the effective spiral pitch much wider. Nevertheless, 'photographs' of the beam (Fig. 3) indicate that about half the electrons are being lost in this way.

So far it has only been possible to extract electrons up to 20 MeV., though there should be no difficulty in extending this to 30 MeV. This limitation is not fundamental, and is due merely to insufficient current from the orbit expansion modulator.

We wish to acknowledge the debt to our colleagues for advice and assistance in this work.

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Atomic Energy Research Establishment,
Harwell. April 17.

[1] Fry, D. W., *et al.*, *Nature*, **161**, 504 (1948).

Production of Beryllium-7 by Proton Bombardment of Carbon

We have detected beryllium-7 in graphite targets after bombardment by 160 MeV. protons accelerated in the 110-in. Harwell cyclotron.

Graphite disks of high purity were irradiated for about one minute, and were found to emit γ-rays with a half-life of about fifty days and energy about 0·5 MeV. (measured by absorption in lead), in addition to the 20-min. positron activity from the well-known[1] reaction $C^{12}(p,pn)C^{11}$. Radiochemical analysis, performed by Dr. F. D. S. Butement, showed that an isotope of beryllium was responsible for the long-period activity. The half-life and γ-ray energy agree with the known values for beryllium-7.

The carbon-11 activity was used as a standard for measurements of the yield of beryllium-7. The irradiated sample was completely enclosed in an aluminium sheath thick enough to stop all the positrons from carbon-11, and its activity measured with a Geiger counter. Since carbon-11 gives no γ-rays, the counter was detecting only the 0·51-MeV. positron annihilation radiation and the 0·48-MeV. γ-rays from beryllium-7; the difference between these energies was sufficiently small to make a counter calibration unnecessary, and the relative yields of carbon-11 and beryllium-7 could be obtained from a decay curve.

In preliminary measurements the cross-section for production of beryllium-7 from carbon-12 by 160-MeV. protons was found to be 11 millibarns $\pm$ 20 per cent. The cross-section for $C^{12}(p,pn)C^{11}$ at 160 MeV. was taken to be 61 millibarns (from results at Berkeley[2]) and the branching ratio[3,4] for the decay of beryllium-7 was assumed to be 0·115.

The possibility that the beryllium-7 might have been formed from carbon-13 or some impurity in the graphite can be ruled out. A cross-section of more than 1 barn would be necessary to produce the observed yield from carbon-13. The total cross-section of carbon for 150-MeV. neutrons is only 0·3 barn[5], and it seems reasonable to assume that no specific nuclear reaction in carbon-12 or -13 can have a cross-section approaching this value for 150-MeV. protons. A similar argument applies in the case of impurities; moreover, irradiations of a $(CH_2)_n$ (polythene) target, containing quite different impurities, gave the same value of the cross-section.

It is therefore assumed that the reaction $C^{12}(p,3p3n)Be^7$ has occurred, with a possibility that the protons and neutrons may be ejected in various combinations involving deuterons, tritons and α-particles.

We are continuing work on this reaction and intend to publish a more complete account. We wish to thank the cyclotron-operating team for their co-operation.

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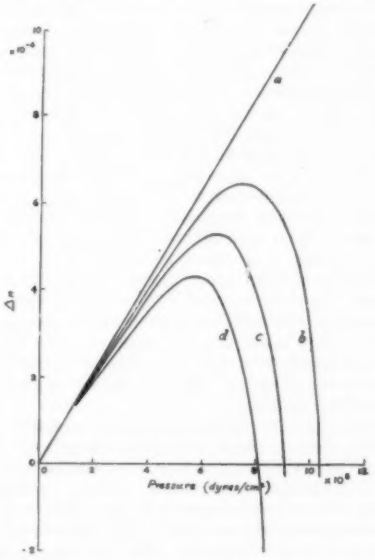
May 22.

[1] Chupp, W. W., and McMillan, E. M., *Phys. Rev.*, **72**, 873 (1947).
[2] Peterson, V. (private communication).
[3] Turner, C. M., *Phys. Rev.*, **76**, 148 (1949).
[4] Williamson, R. M., and Richards, H. T., *Phys. Rev.*, **76**, 614 (1949).
[5] Taylor, A. E., Pickavance, T. G., Cassels, J. M., and Randle, T. C., *Nature*, [**165**, 967 (1950)].

Stress-Birefringence in Polystyrene

The photo-elastic properties of polystyrene at temperatures above its softening point have been investigated earlier[1,2], and it has been found that under these conditions the stress-birefringence is in the opposite direction from that found for most other materials. This is in agreement with the results reported by Signer[3] on the flow-birefringence of polystyrene solutions. Signer pointed out that this behaviour would be expected if it is assumed that, when the molecular chains become aligned, the benzene rings orientate themselves at right angles to the direction of the chains; and, since the optical effect of the benzene rings is greater than that of the main chain, the net stress-birefringence will be *negative*.

No results appear to have been published on the photo-elastic properties of polystyrene at lower temperatures, and on examining the properties of this material in the form of 'Transpex II', it has been found that at room temperature the birefringence is



(a) Instantaneous; (b) 1 min.; (c) 10 min.; (d) 1 hr.

initially *positive* and proportional to the applied stress. The ratio between these two quantities, which is known as the 'stress-optical coefficient', may be seen from curve (*a*) in the accompanying graph to be about 10 brewsters. If stresses above about 10^8 dynes/cm.^{2} are maintained, the birefringence decreases with time, and if the stress is then removed a negative birefringence results. This residual birefringence then relaxes slowly. For pressures greater than 8×10^8 dynes/cm.^{2}, the birefringence is found to pass through zero and become negative even when the stress is maintained.

The graph shows the results obtained at 16° C. with monochromatic light ($\lambda = 5461$ A.) for polystyrene under compression when the stresses have been maintained for various times. These results appear to indicate that two distinct molecular mechanisms take part in the mechanical deformation of polystyrene at room temperature. On first applying a stress, sections of the molecular chains tend to become aligned, and this is associated with the elastic behaviour of the material. When the stress is maintained, however, an orientation of the benzene groups slowly occurs, and this 'flow' takes a corresponding time to relax when the stress is removed. It is hoped to publish fuller results elsewhere of the behaviour at different temperatures.

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[1] Kolsky, H., and Shearman, A. C., *Proc. Phys. Soc.*, **55**, 383 (1943).
[2] Nielsen, L. E., and Buchdahl, R., *J. Chem. Phys.*, **17**, 839 (1949).
[3] Signer, R., *Trans. Farad. Soc.*, **32**, 296 (1936).

Interlamellar Adsorption of Protein Monolayers on Pure Montmorillonoid Clays

Oriented flakes of the fine fractions (less than 0·5 μ) of montmorillonite and hectorite, when dipped in protein suspensions at *p*H values far below their iso-electric point, exhibit a behaviour similar in general to that observed by Gieseking and his collaborators[1]. The difference in technique, however, shows a striking modification in the resulting protein-clay complexes. After immersion in gelatin-suspensions of *p*H 2·5 and concentrations stronger than 1 per cent, unidimensional Fourier syntheses of the X-ray diagrams of the oriented flake suggest that: (*a*) two monolayers, 4·3 A. thick, of the polypeptide chains of the protein are taken up in the interlamellar space, and completely fill it; (*b*) each monolayer is strongly adsorbed on the clay mineral sheets, and a high degree of order along the *c*-axis is obtained in the sandwich thus formed. The X-ray diagram is analogous to that of the glycerol – montmorillonite complex. This lends strong support to the idea that surface adsorptive forces play a major part in the formation of these two-layer organic complexes in montmorillonoid clays.

It is also possible to obtain what appears to be a one-layer (4·8 A. thick) complex of gelatin with a *c*-spacing of 14·2 A. by two alternative methods: (i) by dipping the oriented clay flake in gelatin suspensions at concentrations 0·5 per cent and less; (ii) by dipping a flake of the two-layer complex in a 1 per cent gelatin suspension at *p*H values greater than 3·5. The X-ray diagrams of these flakes suggest that either (*a*) the monolayer taken up does not fill the interlamellar space completely, or (*b*) that the monolayer lies in the interlamellar space in a crinkled state, thus preventing any high degree of order in the *c*-dimension.

It is possible to pass from the one-layer complex into the highly ordered two-layer complex by dipping a flake of the former in a 1 per cent gelatin suspension at *p*H 2·5. Under exceptional conditions, which are difficult to reproduce always (that is, with flakes formed by very slow deposition of the clay particles of less than 0·1 μ diameter), a complex with a *c*-spacing of 26·3 A. is formed (in addition to the two-layer complex) which appears to be a four-layer complex. Like the one-layer complex, the four-layer complex does not show such a high degree of order in the *c*-dimension as is observed in the two-layer complex.

Identical results for the one- and two-layer complexes are obtained with edestin and pepsin suspensions. Flakes dipped in 1 per cent solutions of the amino-acids glycine and arginine at *p*H 2·5 give X-ray diagrams similar to that of the one-layer protein complex, except that the increment in the *c*-spacing is 3·5 A. In all cases the flakes are dried over phosphorus pentoxide in an evacuated desiccator overnight before X-ray examination.

The energy of adsorption between the clay sheets and the protein chains is primarily due to electrostatic forces reinforced by strong Van der Waals' attraction. This is sufficient to cause protein molecules in suspension to uncoil into polypeptide chains, which then easily penetrate the interlamellar space. The two-layer complexes are the most stable of the three kinds observed, each mono-layer being firmly attached to opposite clay surfaces. The thickness of the monolayer observed (4·3 A.) shows that side-chains must lie almost flat on the clay surfaces in the interlamellar space. This is not only in good agreement with the calculated and observed dimensions of polypeptide chains (from X-ray evidence) but also shows a remarkable similarity to 'State III' of the gel films of protein monolayers observed by Rideal and collaborators[2] on an aqueous base, although the orientation of side-chains with respect to the surface of the adsorbent is not the same.

The two-layer complex has some other significant characteristics. There is no uptake of glycerol or water after soaking the flakes in either liquid for more than forty-eight hours in the cold. This hydrophobicity is similar to that of amine-clay complexes described by Jordan[3]. However, the conversion of a compound, strongly hydrophilic in the natural state, into a hydrophobic complex by interlamellar adsorption is remarkable. Prolonged contact with *N* hydrochloric acid has no effect on the complex; with 0·2 *N* sodium hydroxide, the complex shows signs of being attacked slowly after forty-eight hours contact.

Acknowledgments are due to the Department of Scientific and Industrial Research for a grant; and to Dr. D. M. C. MacEwan for originally suggesting the problem on the lines of Gieseking's work.

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[1] Gieseking, *Soil Sci.*, **48**, 467 (1939).
[2] Hughes and Rideal, *Proc. Roy. Soc.*, A, **137**, 62 (1932).
[3] Jordan, *Min. Mag.*, **28**, 598 (1949).

Gabor Diffraction Microscopy : the Hologram as a Generalized Zone-Plate

SINCE the publication of the papers of Gabor on diffraction microscopy[1,2], work has been going on in this Laboratory on the effect of varying the source-hologram distance and the hologram size on the position of the reconstituted image. It proves possible to represent the information obtained in a very simple way by the use of an instructive analogy.

It should be noted that a zone plate is a particular case of an artificially constructed hologram, corresponding to the introduction of a second coherent point source into the diverging beam from the first point source. A zone plate, moreover, when suitably arranged in front of a point source, duly reconstitutes the second point source, together with the symmetrically placed point on the far side of the original source. This follows from the fact that the zone plate has both a positive and a negative primary focal-length.

Pursuing this analogy, we may regard a hologram as a generalized zone plate, which transforms a point source into an image resembling the object used to generate the hologram. It is found that if the distance from the source to the hologram is regarded as the object distance (u), that from the hologram to the reconstituted image being taken as the image distance (v), they are related by the simple lens formula :

$$\frac{1}{v} \pm \frac{1}{u} = \frac{1}{f},$$

the positive or negative sign being taken according to the sign convention used. Hence, it is useful and proper to regard the hologram as having a focal-length f. In common with the zone plate, it acts as both a positive and a negative lens. This accounts for the double image formed, and also explains the observation that, if Gabor's condition that the object must be near the source compared with the hologram is disregarded, the two images are *not* formed symmetrically with respect to the source; but their positions agree exactly with the results of operating on the wave-front from the source with a positive and a negative lens of equal numerical power.

It is found that the effective focal-length of the hologram varies with the wave-length, λ, and with a parameter L, representing the linear scale on which the hologram positive is reproduced from its negative, by the following relationship

$$f \propto \frac{L^2}{\lambda},$$

a result well known to hold for a zone plate[3].

It is a necessary corollary of the existence of the two focal-lengths that the hologram can act as a convex lens, and can thus produce its own reconstruction without the use of the auxiliary lens recommended by Gabor. Since the hologram is essentially a positive photographic reproduction of the Fresnel diffraction pattern of the object in diverging light, and the use of a point source and a hologram alone can only produce a Fresnel diffraction pattern of the hologram, it follows that a two-stage Fresnel diffraction operation can reconstruct an image of the original object. In this way the inverse relationships in the first diffraction operation are re-inverted to give a semblance of the original object, in a way reminiscent of the Abbé theory of microscopic vision and the standard Fourier technique in X-ray crystallography.

There is one point at which the analogy with a zone plate appears to break down. The zone plate not only has a primary focus, but also a number of higher-order foci corresponding to powers which are odd integral multiples of the primary power. This, it seems, arises from the practice of constructing zone plates with abrupt changes from black to white at a sharp boundary, analogous to a square-topped wave. As is well known, a square-topped wave has a large number of Fourier coefficients, and thus the sharper the boundaries in a zone plate, the greater the number of orders obtained. The hologram, on the other hand, produced by a continuous tone photographic process, does not have sharp alternations, but ones more closely conforming to sinusoidal variations; thus we expect the greater part of the diffracted energy to be concentrated in the first-order patterns. The use of an altogether unusual degree of photographic contrast might give rise to higher order effects; but none has been so far observed.

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April 15.

[1] *Nature*, **161**, 777 (1948).
[2] *Proc. Roy. Soc.*, A (July 7, 1949).
[3] See, for example, Jenkins and White, "Fundamentals of Physical Optics", 183 (McGraw-Hill).

Occurrence of 5-Methyl-Cytosine in Nucleic Acids

THE presence in a nucleic acid of the pyrimidine 5-methyl-cytosine was first reported in 1925 by Johnson and Coghill[1], who claimed its discovery among the hydrolysis products of tuberculinic acid. As their identification, however, was based solely on the optical properties of the crystalline picrate, the correctness of this report has been subject to speculation; yet until the recent application of paper chromatography to nucleic acid analysis, there has been no published attempt to confirm their finding. Recently, using a chromatographic method, Vischer, Zamenhof and Chargaff[2] have estimated the purines and pyrimidines in deoxypentose nucleic acid from avian tubercle bacilli, and could find no trace of methyl-cytosine. Hotchkiss[3], however, has noted in hydrolysed thymus nucleic acid a small amount of a substance the chromatographic behaviour and ultra-violet absorption spectrum of which are compatible with its being 5-methyl-cytosine.

Taking advantage of the sensitive photographic technique of Markham and Smith[4] for the detection of ultra-violet-absorbing substances on paper chromatograms, I have now been able to demonstrate and estimate 5-methyl-cytosine in several animal and plant deoxyribonucleic acids, but not in certain viral and bacterial nucleic acids, including that of tubercle bacilli.

The bases liberated by hydrolysis of nucleic acids with formic acid (175° C. for 30 min.) are separated on one-dimensional paper chromatograms using as the solvent an aqueous solution containing 65 per cent *iso*-propanol and 2·0 N hydrochloric acid. In this system, guanine, adenine, cytosine and thymine are separated, in that order, and it was noted first in chromatograms of nucleic acid from herring sperm that a faint additional spot is visible just beyond cytosine, which was also present when hydrochloric acid was used for hydrolysis. A sample of this sub-

stance, isolated by eluting from large sheets of filter paper, was found to give no colour with ninhydrin and to withstand prolonged acid hydrolysis. It moved just ahead of cytosine in all chromatographic solvents tried, whether acid, neutral or ammoniacal.

This suggested that the new substance might be methyl-cytosine. Treatment with nitrous acid gave a product identical with thymine in its chromatographic behaviour and ultra-violet spectrum. Of the three substances which would yield thymine on deamination, the unknown was clearly different from 5-methyl-*iso*-cytosine (2-amino-4-hydroxy-5-methyl-pyrimidine, kindly provided by Prof. A. R. Todd), and was unlikely to be 2,4-diamino-5-methyl-pyrimidine in view of the effect an additional amino-group would have on chromatographic movement. It therefore appeared to be 2-hydroxy-4-amino-5-methyl-pyrimidine or 5-methyl-cytosine.

Recently, through the kindness of Mr. A. Pircio, of Fordham University, New York, I have obtained a sample of synthetic 5-methyl-cytosine, and have confirmed its identity with the natural substance by chromatography and by ultra-violet spectrometry. Absorption maxima occur at the following wavelengths: at *p*H 7, 274 μ; in 0·1 *N* hydrochloric acid, 212 and 283 μ; in 0·1 *N* sodium hydroxide, 287 μ.

Other available nucleic acids were examined for this new pyrimidine. By eluting from chromatograms run in *iso*-propanol-water – hydrochloric acid, concentrating the eluate, and chromatographing in butanol – water – ammonia, amounts of it as small as 1 per cent of the cytosine present (less than 0·1 per cent of the nucleic acid) could be detected and estimated. The following is a list of nucleic acids examined, all of which, except those noted, are of the deoxypentose type.

Source of nucleic acid	Methyl-cytosine content as molar % of cytosine
Calf thymus	6
Beef spleen	6
Ram sperm	5
Herring sperm	8
Locusta migratoria (whole)	1
Wheat germ	33
Tubercle bacilli, human and bovine	0
Escherichia coli	0
E. coli bacteriophages T_2 and T_4	0
Virus of gypsy moth polyhedral disease	0
Yeast (ribose type)	0
Turnip yellow mosaic virus (ribose type)	0

So far, 5-methyl-cytosine has been found only in deoxypentose nucleic acids from animals and higher plants, which contain relatively small amounts characteristic of the source. I am unable to confirm the claim of Rosedale[5] that in the nucleic acids of locusts and certain other insects thymine is quantitatively replaced by 5-methyl-cytosine.

The question arises whether 5-methyl-cytosine is a constituent of the deoxyribonucleic acid macromolecule or of a smaller molecule, perhaps another nucleic acid, mixed in the preparations. Herring sperm nucleic acid fractionated by ultra-centrifugation showed no difference in composition of sediment and supernatant. Nor is its composition altered by precipitation after depolymerization with 1 *N* sodium hydroxide. On the assumption that it consists of a single molecular species, the locust nucleic acid analysed would contain approximately one nucleotide of methyl-cytosine in every 400, corresponding to a molecular weight of about 150,000. In view of the evident complexity and specificity of nucleic acids, there seems to be no reason why this should not be so; yet a further attempt at fractionation would be worth while.

The thymus nucleic acid used was the gift of Dr. K. Bailey; ram sperm nucleic acid was prepared in collaboration with Dr. T. Mann; dried tubercle bacilli were provided by the Wellcome Research Laboratories, Ltd. I am grateful to Dr. K. M. Smith for providing facilities for this work, to Dr. Roy Markham for help and advice, and to Dr. J. D. Smith for preparation and analysis of nucleic acids from *E. coli*, bacteriophages and turnip yellow mosaic virus. The work was carried out while I was on transfer of research from the Division of Entomology, Department of Agriculture, Ottawa, Canada.

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April 3.

[1] Johnson, T. B., and Coghill, R. D., *J. Amer. Chem. Soc.*, **47**, 2838 (1925).
[2] Vischer, E., Zamenhof, S., and Chargaff, E., *J. Biol. Chem.*, **177**, 429 (1949).
[3] Hotchkiss, R. D., *J. Biol. Chem.*, **175**, 315 (1948).
[4] Markham, R., and Smith, J. D., *Biochem. J.*, **45**, 294 (1949).
[5] Rosedale, J. L., *J. Ent. Soc. S. Africa*, **11**, 34 (1948).

"Polyploidy in Rabbits"

In 1948, Prof. G. Häggqvist[1] reported the production of tetraploid frogs (*Rana temporaria*) by colchicine treatment at fertilization, all previous workers having been unsuccessful. Chromosome counts were not made. Instead, tetraploidy was inferred from the relatively greater volume of epidermal nuclei of some treated animals as compared with controls (ratio 1 : 1·87, the theoretical ratio for tetraploidy being 1 : 2·00).

These arguments are open to the objection that large significant differences in mean nucleus size can be found between diploid frog tadpoles, even of the same batch (Beatty, unpublished). In diploid newt larvæ, also, there is great variation between tadpoles, mean nuclear size in some being double that in others[2]. There is thus grave danger of identifying as polyploid a certain number of tadpoles which are, in fact, diploid. The nuclei of the epidermis are flat disks of the same thickness in diploids and polyploids, and the volume of which is roughly proportional to their *area* as seen through the microscope. Häggqvist, however, calculated a mean diameter and then estimated nuclear volume as if for a *sphere*, stating that this source of error should be of the same magnitude in different cases, and should not affect comparison of one animal with another. This is clearly an error in arithmetical procedure. The corrected ratio of the epidermal nuclei is 1 : 1·52 (= 1 : 1·8[illegible]). If significant of anything at all, this suggests triploidy rather than tetraploidy. In controls, measurements of nuclear size in one tadpole gave a ratio quoted as 1 : 1·51, from which triploidy was inferred; the correct figure here is 1 : 1·31, and is thus rather less close to the 1 : 1·50 ratio expected for a triploid. Häggqvist claims that the alleged triploids and tetraploids of the frog are giant forms. This conflicts with all the literature on the subject of size of polyploid Amphibia (possible minute differences excepted), and is to our personal observation untrue for triploid tadpoles of *Rana temporaria* (unpublished experiments of Mr. R. Douglas). Häggqvist describes various unfortunate circumstances, including loss of the proper controls, that had hampered the progress and supervision of the work. We have, therefore, to

conclude that the whole of this work requires confirmation.

In *Nature* of May 27, Häggqvist and Bane[3] now report a litter including one diploid and two "triploid" rabbits, after a colchicine treatment said to be essentially the same as that used for producing tetraploidy in frogs. This work, again, was achieved without benefit of chromosome counts. One of the "triploid" rabbits was a male with normal sexual instincts, one was a female. Both showed large size. As a criterion for "triploidy", erythrocytes from the two animals were stated to be about 50 per cent larger than in other rabbits. Original data were withheld for future publication, and there was no note of the number of preparations made, nor the mode of calculating volume of erythrocytes. The sperm heads in the male were stated to be about 50 per cent larger than normal. As admitted by Häggqvist and Bane themselves, the disturbed spermatogenesis expected of a triploid was not evidenced by any variation in the size of sperm-heads.

Häggqvist and Bane quote Beatty[4] (mistakenly quoted as Beatty and Fischberg[5]) for a method of determining heteroploidy by analysis of nucleoli. This work was concerned with the special problem of analysing heteroploidy in non-mitotic cells in which, *ipso facto*, the possibility of counting chromosomes was excluded. We should like to record our opinion that, in all normal circumstances, claims for polyploidy must rest on chromosome counts and not on indirect evidence. Our own work with polyploid mouse embryos is so based[6-7], and recently (unpublished) we have identified several triploid 9½-day mouse embryos (this being exactly half the full gestation period). With rabbits, Häggqvist and Bane state, "In determining the degree of polyploidy, a chromosome count can scarcely be considered in this case". Here, we cannot agree; a chromosome count seems to us to be both essential and practical, being simply a routine matter of examining preparations of skin—or, better, of the cornea of an eye; with the male, a testicular biopsy could be made. We feel that the onus is on Häggqvist and Bane to produce unambiguous evidence in support of their startling claim for triploid adult rabbits. Their claim, if verified, would evidently be of extraordinary interest and importance.

Note added in proof. During the printing of our letter, two further papers have appeared concerning Häggqvist and Bane's rabbits[8,9]. In one of these papers (Melander[9]) a detailed examination of numerous cell divisions in the "triploid" male shows that the animal is neither triploid nor polyploid, but contains many aneuploid and diploid mitoses. The testes show in addition a number of triploid cell divisions.

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Organisation, Institute of Animal Genetics,
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June 5.

[1] Häggqvist, G., *Proc. Koninkl. Nederland. Akad. Wetensch.*, **21**, 405 (1948).
[2] Fischberg, M., *Genetica*, **24**, 213 (1948).
[3] Häggqvist, G., and Bane, A., *Nature*, **165**, 841 (1950).
[4] Beatty, R. A., *Nature*, **163** 644, (1949).
[5] Beatty, R. A., and Fischberg, M., *Nature*, **163**, 807 (1949).
[6,7] Fischberg, M., and Beatty, R. A., 9. *Jahresbericht der Schweiz. Ges. für Vererbungsforschung, Arch. der Julius Klaus-Stiftung für Vererbungsforschung*, **25**, 22[1] and 54[3] (1950).
[8] Häggqvist, G., and Bane, A., *Hereditas*, **36**, 329 (1950).
[9] Melander, Y., *Hereditas*, **36**, 335 (1950).

Nitrification of Amino-Acids

In the reported discussion of the "Nitrogen Cycle in Nature" at the Newcastle meeting of the British Association, reference was made to Prof. J. H. Quastel's observation that "all the amino-acids studied nitrify readily with the striking exception of methionine". The report does not mention cystine in this connexion. In the course of work in progress here, we have in one experiment found cystine to cause marked inhibition of nitrification. The addition of amino-acids such as glycine or glutamic acid to batches of soil resulted in a rapid increase in ammonia, usually within two to four days, after which the ammonia values fell as nitrification proceeded. In the case of cystine, however, deamination was slower, reaching a maximum for ammonia in twenty-eight days, while the nitrate of the soil decreased slowly during the same period. At the end of six weeks, when nitrification of the other amino-acids had reached its maximum, only 10 per cent of the nitrogen in cystine had been nitrified and 75 per cent of it was recovered as ammonia.

O. Owen
G. W. Winsor

Experimental and Research Station,
Cheshunt, Herts. Nov. 23.

[1] *Nature*, **164**, 812 (1949).

As shown in our earlier paper[1], many amino-acids are nitrified during soil perfusion, at rates comparable with that of an equivalent concentration of ammonium ions; but the rates are dependent on soil conditions. With an acid soil, glycine is nitrified more readily than ammonium chloride or sulphate; with an alkaline soil the rates are about the same. This is due to the fact that the optimal rate of nitrification requires somewhat alkaline conditions (*p*H 8). Amino-acids, owing to the fact that they do not liberate a mineral acid, apart from nitric, on nitrification, do not depress the *p*H of soil as much as occurs with ammonium chloride or sulphate. Cysteine, however, is exceptional in giving rise, on oxidation by soil heterotrophs, to sulphuric acid, and the fall of *p*H of soil due to cysteine oxidation is largely responsible for its depressed rate of nitrification. There appears to be no serious interference with the course of nitrification of ammonium ions by cysteine during soil perfusion, except for a general slowing down due to increasing acidity.

The phenomenon is altogether different from that encountered with the nitrification of *dl*-methionine. This amino-acid is not nitrified at all during a period (about eleven days at 25° C.) when an equivalent concentration of cysteine has undergone about 50 per cent nitrification, and ammonium chloride about 80 per cent. Moreover, whereas the addition of cysteine does not diminish the rate of nitrification of ammonium chloride more than 10 per cent during the first ten days of soil perfusion, the addition of methionine completely suppresses the rate of nitrification of ammonium ions in this period. This highly inhibitory effect of methionine on nitrification is also given by methionine sulphoxide and is unique among the amino-acids so far investigated by us. A study of this phenomenon, and its interpretation, is the subject of a communication which will shortly be sent to press.

J. H. Quastel
P. G. Scholefield

McGill University, Montreal.

[1] Quastel and Scholefield, *Nature*, **164**, 1068 (1949).

FORTHCOMING EVENT

Saturday, August 12—Friday, August 18

OXFORD UNIVERSITY DEPARTMENT OF EDUCATION (at Magdalen College, Oxford).—Third Conference on "The Education of the Young Worker—Reception and Initiation into Work".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN AGRICULTURAL SCIENCE, with particular emphasis on farm machinery and implements, at the Shropshire Farm Institute, Walford, near Baschurch—The Secretary for Education, County Buildings, Shrewsbury (August 10).

ASSISTANT LECTURER IN AGRICULTURE—The Clerk to the Governors, Essex Institute of Agriculture, Writtle, Chelmsford (August 11).

BIOCHEMIST (non-medical) in the Area Pathological Laboratory—The Secretary, Shotley Bridge General Hospital, Co. Durham (August 12).

ENGINEERS and PHYSICISTS (unestablished) at a Ministry of Supply Design Establishment near London: Principal Scientific Officers, one to take charge of a section dealing with the development of new projectiles, the other to take charge of a section dealing with the stressing of redundant complex structures, and a Scientific Officer for design and development of guns, including the study of internal ballistics and combustion problems—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.367/50A (August 12).

GRADUATE TEACHER OF SCIENCE in the Science Department—The Principal, London School of Printing and Graphic Arts, 61 Stamford Street, London, S.E.1 (August 12).

LECTURER IN THE ELECTRICAL ENGINEERING DEPARTMENT—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (August 12).

LECTURER IN MATHEMATICS—The Principal, Acton Technical College, High Street, Acton, London, W.3 (August 12).

PHYSICAL CHEMIST or a suitably qualified CHEMIST, for investigations into physico-chemical methods of analysis such as colorimetry, absorptiometry, chromatography and polarographic analysis, with the object of adapting them to the particular requirements of the Chemical and Metallurgical Sections of the Executive's Laboratory Service—The Staff Officer (F./EV.137), London Transport Executive, 55 Broadway, London, S.W.1 (August 12).

SENIOR ASSISTANT (with a good degree in physiology) IN THE DEPARTMENT OF PHARMACY and BIOLOGY, and a LECTURER (with special responsibility in zoology) IN THE DEPARTMENT OF PHARMACY and BIOLOGY—The Registrar, Central Technical College, Suffolk Street, Birmingham 1 (August 12).

ELECTRONIC ENGINEERS or RADIO PHYSICISTS (Scientific Officer grade unestablished) at the Ministry of Supply London headquarters—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.215/50A (August 14).

LECTURER or SENIOR LECTURER (with special qualifications in mycology) IN AGRICULTURAL BOTANY, and a DEMONSTRATOR IN BOTANY—The Registrar, The University, Leeds 2 (August 14).

SENIOR PHYSICIST—The Secretary to the Management Committee, Liverpool Radium Institute, Liverpool (August 14).

LECTURER (Grade II) IN THE DEPARTMENT OF CIVIL ENGINEERING—The Secretary, The University, Birmingham 3 (August 15).

ASSISTANT DIRECTOR OF EXAMINATIONS (university graduate with honours, preferably first-class, in natural sciences with chemistry or physics as a main subject and should preferably have qualifications in two or more subjects (physics, chemistry, botany, biology, zoology, etc.)—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 3193 (August 17).

ENGINEERS (Scientific Officer (Ref. C.382/50A) and Experimental Officer (Ref. C.383/50A) grades, unestablished), at the Royal Aircraft Establishment, Farnborough, particularly for experimental and design work on light mechanical and electro-mechanical engineering problems, including servos and for work in the field of aeronautics and ballistics—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (August 17).

POSTGRADUATE SCHOLARSHIP at a university college or approved research institution in New Zealand—The New Zealand Scientific Office, Africa House, Kingsway, London, W.C.2 (August 17).

ASSISTANT LECTURER IN CHEMISTRY, with special interests in organic chemistry—The Registrar, The University, Manchester 13 (August 18).

ELECTRONIC ENGINEERS and PHYSICISTS (Scientific Officer and Experimental Officer grades, unestablished), at the Royal Aircraft Establishment, Farnborough, particularly in the fields of radio communications, including microwave techniques, circuit design and measurements, servo mechanisms and measurement of flight parameters—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.220/50A (August 19).

ASSISTANT CIVIL ENGINEER (temporary) at the Building Research Station of the Department of Scientific and Industrial Research—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting E.281/50A (August 21).

ASSISTANT LECTURER IN THE DEPARTMENT OF GEOGRAPHY—The Registrar, The University, Liverpool (August 21).

DEMONSTRATOR IN THE DEPARTMENT OF CHEMISTRY AND BIOCHEMISTRY—The Dean, St. Thomas's Hospital Medical School, London, S.E.1 (August 21).

ASSISTANT CHEMIST IN THE WATER EXAMINATION DEPARTMENT—The Clerk, Metropolitan Water Board, New River Head, Rosebery Avenue, London, E.C.1 (August 25).

PRINCIPAL RESEARCH OFFICER or SENIOR RESEARCH OFFICER in the Coal Research Station, Chatswood, N.S.W.—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 1987 (August 26).

LECTURER IN MATHEMATICS at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 31).

LECTURER IN PSYCHOLOGY (including experimental psychology)—The Secretary, The University, Aberdeen (September 15).

JOHN MURRAY TRAVELLING STUDENTSHIP IN OCEANOGRAPHY AND LIMNOLOGY—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (September 16).

LECTURER or SENIOR LECTURER IN FLUID DYNAMICS at the University and Hobart Technical College, Tasmania—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 30).

PROFESSOR OF ELECTRICAL ENGINEERING—The Registrar, College of Technology, Manchester 1 (September 30).

ASSISTANT DRILLING ENGINEER (with a degree in mechanical or mining engineering or equivalent Institute qualifications, with practical experience) in the Geological Survey (Public Works Department), Sudan Government—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Assistant Drilling Engineer'.

ASSISTANT EXPERIMENTAL OFFICERS in various Government departments throughout Great Britain, for posts covering a wide variety of scientific (including engineering) qualifications—The Secretary, Civil Service Commission, Scientific Branch, 7th Floor, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3068.

JUNIOR LECTURER (with a first- or second-class honours degree in electrical engineering or equivalent qualifications, preferably with works experience), IN THE DEPARTMENT OF PHYSICS AND ELECTRICAL ENGINEERING—The Director of Studies, Royal Naval College, Greenwich, London, S.E.10.

LECTURERS with first- or second-class honours degree in mechanical engineering—The Director of Studies, Royal Naval College, Greenwich, London, S.E.10.

METEOROLOGISTS (with a first- or second-class honours degree in mathematics or physics) for the West African Meteorological Service—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27118/4.

SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS in various Government departments, for posts covering a wide range of scientific research and development in most of the major fields of fundamental and applied science—The Secretary, Civil Service Commission, Scientific Branch, 7th Floor, Trinidad House, Old Burlington Street, London, W.1, quoting No. 2887.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Empire Cotton Growing Corporation. Progress Reports from Experiment Stations, Season 1948–1949. Pp. ii+172. (London: Empire Cotton Growing Corporation, 1950.) 3*s*. [136

An Alternative to Avogadro's Hypothesis and a Theory of Atomic Conjunction. By William Norland. Pp. 30. **The Interpretation of Adjusted Gas Reactions and Atomic Compactness in Inert Gases.** By William Norland. Pp. 24. (St. Helens: The Author, Heathway, Crossley Road, 1950.) [136

Report of the Astronomer Royal to the Board of Visitors of the Royal Greenwich Observatory. Pp. 29. (Greenwich: Royal Observatory, 1950.) [136

Second Report of the Hospital Equipment Standards Advisory Committee. (CM/OC/1178.) Pp. 8. (London: British Standards Institution, 1950.) 6*d*. [136

Other Countries

First Annual Report of the Commonwealth Scientific and Industrial Research Organization for the Year ended 30th June, 1949. Pp. 137. (Canberra: Commonwealth Government Printer, 1949.) 7*s*. 9*d*. [66

Commonwealth Scientific and Industrial Research Organization. Bulletin No. 239: Foundry Sand Resources of New South Wales. By H. A. Stephens and H. F. Whitworth. Pp. 68+9 plates. **Bulletin No. 245: Behaviour of Swarm Hoppers of the Australian Plague Locust, *Chortoicetes terminifera* (Walker).** By L. R. Clark. Pp. 27. (Melbourne: Government Printer, 1948–49.) [96

Bulletin of the Museum of Comparative Zoology at Harvard College. Vol. 103, No. 4: **The Spider Genus *Tmarus* (Thomisidæ) in Panama.** By Arthur M. Chickering. Pp. 211–255+4 plates. (Cambridge, Mass.: Harvard College, 1950.) [136

Annals of the New York Academy of Sciences. Vol. 50, Art. 9: **Antihistamine Agents in Allergy.** By Frederick F. Yonkman and 15 other Authors. Pp. 1013–1208. (New York: New York Academy of Sciences, 1950.) 3 dollars. [136

Catalogues

Engineering Bulletin. No. 251, March: **The Digit Switch.** Pp. 4. (London: Siemens Brothers and Co., Ltd., 1950.)

Chance Optical Glass. (O.S. 6.) Pp. 20. (Smethwick: Chance Brothers, Ltd., 1950.)

Lancashire-Crypto in Industry. (M.L. 66.) Pp. 8. **Crypto Electric Hand and Face Drier.** (C.L. 72.) Pp. 4. (Manchester and London: Lancashire Dynamo and Crypto, Ltd., 1950.)

Rohm and Haas Reporter. Vol. 8, No. 1, February–March. Pp. 26. (Philadelphia: Rohm and Haas Company; London: Charles Lennig and Co. (Great Britain), Ltd., 1950.)